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ABSTRACT

A study investigated changes in recognition time for short sentences presented on television screens of varying sizes with viewers at varying distances. In a posttest only control group design, subjects in several different groups viewed a series of similar sentences under conditions where screen size and distance from the screen were varied. The subjects' scores were subjected to a one-way analysis of variance, thd results showed that recognition time decreased as the subject was moved closer to the television screen and as the screen size was increased. The study suggests, then, that variables such as set size and viewer distance should be considered by graphics designers for both commercial and educational purposes. (SH)

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SOME EFFECTS OF TELEVISION SCREEN SIZE AND VIEWER DISTANCE ON RECOGNITION OF SHORT SENTENCES

Earl P. Lewin

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by

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A thesis submitted in partial fulfillment
of the requirements for the Master of Science degree
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TABLE OF CONTENTS

Chapter Page

APPENDICES

LIST OF TABLES

LIST OF FIGURES

Chapter 1

INTRODUCTION

This study was designed to investigate changes in recognition time for short sentences presented on television screens of varying sizes with viewers situated at varying distances. The purpose of the investigation is discussed in this chapter and the problem to be investigated is formulated. Working definitions are stated and specific hypotheses given with assumptions and limitations inherent in the design of this experiment. Literature pertinent to the subject of screen size and viewer distance is reviewed and the conclusion drawn that a perception time effect caused by viewer distance changes might exist, but that such an effect has not been specifically isolated for formal investigation relative to the television viewer.

PURPOSE

In the presentation of written matter as a part of television programming, it is possible that perceptual factors which are being ignored by graphics producers are preventing recognition of a given message to occur for large portions of the target audience. Such situations may be costing advertisers large quantities of money for far smaller results than are potentially available to them.

Before a television graphic can be scientifically designed for readability of written matter, two factors, which it would appear are not being considered, must be taken into account: the size of the sets on which the target audience is likely to view the material and the range of distances viewers are likely to be situated from the face of their television sets when the message is presented.

In telephone interviews with the graphics directors of three major television stations in Philadelphia, Pennsylvania, (Appendix A) viewer distance and receiver set size were not mentioned by designers as factors to be considered in graphics production. In conversations with a producer of television commercials for a major advertising agency in New York City,[1] it was reasserted that these viewer aspects are not considered a part of graphics design requirements.

The perception time effect caused by viewer distance and television screen size, (which, from this point on in this study will be referred to as the Distance and Size Perception-Time Effect) if indeed it does exist, may also affect other types of visual data transmission and call for subtle changes in duration of picture exposure depending on the size of the screen being used for reception, or the distance at which the viewer or viewers are expected to be placed from the point of visual presentation.

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[1]Statement by Barry Kadische, personal interview, Batton, Barton, Durstine and Osborne, 385 Madison Ave., New York, N.Y., 10022, March 24, 1972.

Recent experiments in visual masking by psychologists and on media effects by educators and communicators, in which screen size has been sometimes a controlled and sometimes an overlooked variable, have produced a variety of results. Conflicting conclusions may be related to the failure of experiments to account for Distance and Size Perception-Time Effects.

> "The conflicting and often unsubstantiated recommendations presently available define a basic lack of knowledge of the physical conditions which maximize visual perceptions of television images."[2]

Study of this aspect of visual perception may provide guidelines to educators as well as professional graphics producers through demonstrated effects that television screen size may have on the time required to grasp a given communication.

This study was designed to isolate the specific variables of screen size and viewer distance and quantitatively measure differences in exposure duration required for recognition to take place under varied conditions of screen size and subject distance.

Better understanding of the relationships of size and distance to visual perception of material presented on a television screen should add to the growing body of knowledge in audiovisual technique and visual perception and, perhaps, make a contribution to the eventual formulation of a comprehensive theory of visual perception.

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[2] Lewis Bowers O'Donnell, "Determination of Optimal Angles and Distances for Viewing Alphanumeric Characters and Geometric Patterns on a Television Receiver" (unpublished Doctor's dissertation, University of Syracuse, 1970), p. 5.

PROBLEM

With picture proportions, contrast, brightness and incident light held constant, does increased screen size change the exposure time required for a viewer to recognize a short sentence presented on a television screen which is a fixed distance from the viewer?

Does the time required for recognition of a short sentence presented on a television screen change if the picture proportions, contrast, brightness, incident light and screen size are held constant while the viewer's distance from the television screen is changed?

Is the visual angle or apparent size of the visual a contributing factor in any effect that might be present, and can such effect be predicted numerically?

DEFINITIONS

The following working definitions were used in setting up and interpreting this experiment.

Picture Proportions

Size of the stimulus sentence with respect to the total screen area was kept constant by using a standardized video taped series of messages of constant size which were delivered through an electronic switcher to television monitors having screens of varying sizes.

Contrast

Ratio of sentence to background and light to dark background contrast was established by judgement across 4 different sized screens by 2 observers, the test conductor and assistant, prior to each series of tests.

Brightness

Light output of each television screen displaying a stimulus sentence was measured with a Spectra Exposure Meter (Model S-500 No. 6586 Photo Research Corp., Hollywood, Calif.). The level was set to 24 foot-candles (258.34 lumen/ $m.^2$) measured 6 inches (15.24 cm.) from the set at the screen's center.

Incident Light

Four to 6 foot-candles (43.06 to 64.58 lumens/$m.^2$) were measured from the center of the television screens looking away from the sets directly into the room. Light was from a table lamp with a 60-watt bulb and a translucent shade. The lamp was 9 feet (2.74 m.) from the nearest television screen and to the right of the subject so that no reflections were visible on the television screens to a subject seated in any of the test positions. It has been suggested that two symmetrically placed lamps be used to provide more balanced lighting but this would still allow some variation across the screens and at the same time be less like the normal home viewing situation.

Increased Stimulus Size

A prepared video tape of picture elements only was played on a larger size television screen to increase stimulus size and a smaller size screen to decrease stimulus size.

Change

A statistically significant experimentally measured decrease or increase in required exposure time for recognition to occur was considered a change in visual recognition time for stimuli presented on larger or smaller screens or at greater or lesser distance fror [illegible]r.

Viewer

Viewers were engineers of the General Electric Company with a mean age of 40 years. Participants were selected randomly from a company personnel list using the last digit of randomly assigned employee numbers.

Recognize

A verbally reported correct stimulus sentence was considered to represent recognition.

Distance

Subject's distance was measured from the surface of the television screen to the center of the seat of the viewer's chair -- an executive office chair, plastic covered with padded seat, back, and arms. Seat cushion to floor measured 16 inches (40.64 cm.). Leading edge to base of back measured 18 inches (45.72 cm.). The back height was 30 inches (76.20 cm.).

Short Sentence

Each 4-word stimulus sentence was composed of a 4-letter word, a 3-letter word, a 5-letter word and a 6-letter word in a meaningful statement such as "save the green forest". A series of 27 such sentences were superimposed over a gray breaking surf background. Each sentence was presented 12 times at increasing exposure rates from 41.667 msec. (1 16-mm. motion picture frame) adding 41.667 msec. each time of exposure, up to a total of 500 msec.

Presented

Stimuli were displayed on a television screen starting with an elapsed time of 41.667 msec. from effective exposure start to stop. Elapsed time was increased by 41.667 msec. at each effective exposure start to stop up to a duration of 500 msec. One second of background picture separated each unit of stimulus elapsed time. Each block of 9 sentences, making up the total of 27 sentences, was separated by 3 seconds of background picture.

Television Screen

Screens used for the experiment were 8-inch, 12-inch, 15-inch and 23-inch (20.32, 30.48, 38.10, and 58.42 cm.) measured horizontally, commercial television monitors for black and white reception.

Time Required For Recognition

Time was calculated in msec. and represents a total of the time the subject was exposed to the stimulus sentence including the time through the end of that exposure during which recognition was accredited to have occurred.

Visual Angle or Apparent Size

The visual angle refers to the height of the stimulus sentence as it is described by two lines, one to the top of the letters forming the stimulus sentence, one to the bottom of letters forming the stimulus sentence with the lines diverging from the same point at the viewers eye. This angle is called the visual angle and changes with stimulus size change or with a change in viewer distance from the stimulus. This angle determines the apparent size of the stimulus given no other references. For finer discrimination, the purist would rightfully insist that the visual angle refers to a point that is technically within the eye but that degree of accuracy is not required for the present study.

HYPOTHESES

Television screen size affects recognition time of a written message when the message remains proportionally the same size to the overall size of the screen, subject distance from the set is held constant, but the size of the screen for viewing is changed.

Distance from the television screen affects recognition time of a written message when the message's physical size and screen size are held constant, and viewer distance is varied.

If stimulus size is changed, then viewer distance is adjusted so that the visual angle remains the same (the apparent size of the stimulus remains the same), recognition time will not be affected.

For a given message (printed matter) presented on a television screen, there is a minimum length of time that it must be exposed for recognition to occur. That length of time, affected by the message's physical size and the viewer distance from the screen, can be roughly predicted by developing a "rule-of-thumb" formula to cover a given range of conditions for viewing a given visual stimulus.

ASSUMPTIONS

When picture proportion, brightness and contrast of a television picture and incident room lighting are held constant, and visual angle is changed either because of viewer distance from the set changing or actual change in physical size of the television set, any observed difference in recognition time for sentences presented on that set will be the result of the change of viewer distance or the change in physical size of the television set.

With randomized subjects, the data obtained in experimentally studying this effect will reflect the change in recognition time related to television set size and viewer distance rather than some inherent characteristic of the subjects selected for testing.

Within the range of distances and set sizes being studied in this experiment, it is assumed that if an effect related to distance and set size exists, it is a linear function within the limits of the conditions set up in the present study.

It is assumed that all equipment, facilities and test personnel will function at the same levels of performance for each administration of the test.

LIMITATIONS

The results of this study will specifically apply only to 4-word 18-letter sentences comprised of familiar words presented over a black and white moving picture ocean background and occupying approximately 49.3% horizontal and 3.7% vertical picture area. Data were collected for 4 screen sizes only. All subjects were professional aerospace engineers. It is hoped that the results will be generalizable to other situations and will lead to further experimentation in the same area.

REVIEW OF THE LITERATURE

A search of literature was conducted to find if the effect of screen size or viewer distance on perception time had been adequately treated in formal study. The search is described here. The result of that search is discussed and conclusions are drawn from an integrative study of the literature.

Literature Search

Initially, two computer searches were conducted, one by the Defense Documentation Center, Defense Supply Agency, Cameron Station, Alexandria, Virginia,[3] and a second by the National Aeronautics and Space Administration, Scientific and Technical Information Division, Washington, D.C.[4] These searches were initiated to find any government studies that had been performed to identify differences in perception relative to different screen sizes.

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[3] An Analysis of TV and Movie Screens, Comparison of TV and Movie Screens, Search Control Number 60297 (Alexandria, Virginia: Defense Documentation Center, Defense Supply Agency, Cameron Station, 1971), passim.

[4] Television and Motion Pictures as Visual Aids and Comparison of Media, NASA Literature Search Number 15385 (Washington: NASA Scientific and Technical Information Division, 1971), p.p. 1-30.

Volumes of Dissertation Abstracts International[5] were searched from the years 1961 through 1971 and, using the Dissertation Abstracts International Retrospective Index,[6] for the years 1938 through 1969.

Headings searched in Volumes 30 through 32 and the Retrospective Index were: display, distance, image, motion/moving picture, perception, screen, size, television, visual, and psychology, experimental. For Volumes 22 through 29, the headings information display systems, moving picture, perception, and television were searched. Bibliographic Index[7] was searched for the years 1947 through 1970. Headings investigated in that document were: information display systems, moving picture, perception, and television. Journal of the Society of Motion Picture and Television Engineers[8] was searched for the years 1956 through 1971 under the headings screen and television. The card files of Temple University Library, Philadelphia, Pa., Philadelphia Public Library Main Branch, and Rutgers University Library, Camden, N.J., were searched under subject headings, perception, vision, visual perception, visual presentation.

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[5] Dissertation Abstracts International (Ann Arbor: University Microfilms, 1961 through 1971), Vol. 22 through Vol. 32.

[6] Dissertation Abstracts International Retrospective Index (Ann Arbor: University Microfilms, 1970), Vol. IV, VII, and VIII.

[7] Bibliographic Index (New York: The H. W. Wilson Company, 1947 through 1970), Vol. 3 through Vol. 10.

[8] Journal of the Society of Motion Picture and Television Engineers (New York: SMPTE, 1956 through 1971), Vol. 65 through Vol. 80.

Results of the Search

Inquiries have regularly been made into the nature of visual perception.[9] Additionally, scholars and other professionals concerned with visual communication have accumulated data on the production of visual materials for media.[10]

Of the published work on visual communication, none quantitatively investigated the effect of subject distance and visual stimulus size on the recognition time of written copy presented on a television screen. Distance and Size Perception-Time Effects were substantially neglected in the visual perception experiments conducted to date.

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[9]See, for example Sir John Herbert Parsons, An Introduction to the Theory of Perception (New York: The Macmillan Co., 1927); Jean Piaget, The Mechanisms of Perception, trans. G.N. Seagrim (New York: Basic Books, Inc., 1961); David C. Beardslee and Michael Wertheimer, Readings in Perception (Princeton: D. Van Nostrand Co., Inc., 1963); M. Dorothea Vernon, The Psycology of Perception (London: University of London Press, 1965); M. Dorothea Vernon (ed.), Experiments in Visual Perception (Middlesex: Penguine Books Ltd., 1966); Daniel J. Weintraub and Edward L. Walker, Perception (Belmont: Brooks Cole Publishing Co., 1966); Ross Parmenter, The Awakened Eye (Middletown: Wesleyan University Press, 1968), Ralph Norman Haber (ed.), Contemporary Theory and Research in Visual Perception (New York: Holt, Rinehart and Winston, Inc., 1968); Ralph Norman Haber (ed.), Information - Processing Approaches to Visual Perception (New York: Holt, Rinehart and Winston, Inc., 1969); and Richard L. Gregory, The Intelligent Eye (New York: McGraw-Hill Book Co., 1970).

[10]See, for example James J. Gibson (ed.), Army Air Forces Aviation Psychology Program Research Reports, Report No. 7 (Washington: Government Printing Office, 1947); C.R. Carpenter, L.P. Greenhill and others, Project Number One An Investigation of Closed-Circuit Television for Teaching University Courses (University Park: Pennsylvania State University, 1955); C.R. Carpenter, L.P. Greenhill and others, Project Number Two An Investigation of Closed-Circuit Television For Teaching University Courses (University

A study of Seibert, Kasten and Potter in 1959 tested the legibility of televised alphanumeric characters with 36 volunteer college students. Subjects were positioned at 3.8-foot intervals of distance from the receiver, directly on the axis and at angles of about 19 and 39 degrees. Viewing distances ranged from 6 to 38 feet. The results demonstrated significant differences at the 0.01 level in the percent of stimulus letters correctly identified as distance was changed. At a distance of 6 feet, 88.9 percent of the letters were correctly identified while only 30.7 percent were correctly identified at the 25-foot distance.[11]

Seibert, et al, further noted that as subtended arc decreased, characters were recorded with decreasing accuracy.[12] It would appear that the possible significance of this observation to graphics production, screen time, screen size, and viewer distance was not picked up and carried to any meaningful conclusion.

Park: Pennsylvania State University, 1958); Charles E. Sherman, "An Investigation of Experimental Research in Selected American Professional Journals of Psychology from 1955 to 1961 Applicable to the Production Techniques of Graphic Visual Stimuli in Instructional TV" (unpublished Master's thesis, Temple University, 1962); Rudolph Bretz, Techniques of Television Production (New York: McGraw-Hill, 1962); Dr. Earl A. Taylor, A Manual of Visual Presentation in Education and Training (New York: Permagon Press, 1966); Gerald Millerson, The Technique of Television Production (Harford Works: Fletcher and Son, Ltd., 1966); and Herbert Zettl, Television Production Handbook (Belmont: Wadsworth Publishing Co., 1968).

[11] Warren F. Seibert, Duane F. Kasten and James R. Potter, "A Study of Factors Influencing the Legibility of Televised Characters," Journal of the Society of Motion Picture and Television Engineers, 68:468, July 1959.

[12] Ibid., p. 470.

In studies such as those by O'Donnell,[13] Murphy[14] and Bollman,[15] effects due to stimulus size and distance relationships were reported, but were not the specific objective of the studies and, therefore, not specifically investigated.

O'Donnell was primarily concerned with the lack of adequate guidelines concerning the number of students who should watch a single television receiver and what specific angles and distances of viewing should be established. His results showed that distance from the set affected accuracy of response for both alphabetical and geometric patterns and pointed to the operation of some perceptual effect related to distance but did not develop this point. Murphy, working with deaf learners, found image size to have a slight though statistically nonsignificant effect upon learning visual material and recommended a study of increasingly larger images at a fixed distance. Bollman wanted to determine if large screen, multi-image presentation affected evaluative meaning. Although a a systematic main effect was detected, it could not be ascribed statistically to the multi-image presentation, but it did appear that a more positive shift in evaluative meaning was associated with viewer distance from the screen.

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[13] Lewis Bowers O'Donnell, "Determination of Optimal Angles and Distances for Viewing Alphanumeric Characters and Geometric Patterns on a Television Receiver" Dissertation Abstracts International, 31:5943-A, May, 1971.

[14] Harry James Murphy, "The Effects of Types of Reinforcement, Color Prompting, and Image Size Upon Programmed Instruction with Deaf Learners," Dissertation Abstracts International, 31:2742-A, December, 1970.

[15] Charles Gene Bollman, "The Effect of Large-Screen, Multi-Image Display on Evaluative Meaning," Dissertation Abstracts International, 31:5924-A, May, 1971.

Studies such as Filderman's[16] and Moore's[17] confronted the size, distance, acuity problem and showed that some effect operated but both involved other factors that tended to make results unclear on the question of exact and scientific stimulus size and viewer distance relationships. Additionally, neither study was directed to television viewing.

Filderman experimented with visual acuity of printed cards at 14-inch and 20-foot distances and found that visual acuity factors in operation at the one distance were different from visual acuity factors in operation at the other.

Moore set out to see what effect size and type of still pictures (line drawings, photographs) had on immediate recall of content. He found small size projected pictures least effective and medium size projected pictures most effective with distance and lighting held constant. Larger sizes were less effective than medium sizes in Moore's experiment and may indicate a bell curve. The Moore study, and the previously mentioned Bollman study, were projected images but went well beyond the size of the largest television screen and, in that respect, were beyond the scope of the experimental set up of the present study.

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[16] Irving Paul Filderman, "An Analysis and Investigation of the Relationship Between Distance and Near Visual Acuity Among One Hundred and Twenty Fourth, Fifth and Sixth Grade Students," Dissertation Abstracts International, 31:5841-A, May, 1971.

[17] David Michael Moore, "An Experimental Study of the Value of the Size and Type of Still Projected Pictures on Immediate Recall of Content," Dissertation Abstracts International, 31:5041-A, April, 1971.

A study by Dr. J. M. Pokorny[18] at Columbia University in 1967 scientifically illustrated a relationship between size of stimulus and illumination and contrast of the stimulus but his findings were not applied to problems of visual perception of television messages.

Pokorny devised an experiment to determine acuity threshold and found that the larger his target became, the less luminance was required to perceive it and the greater the luminance, the smaller the target could be for perception. This finding showed, within an accepted range of visability and in conjunction with illumination, target size might possibly be one of the variables in visual perception time. This seems to agree with findings by Dr. Hufford[19] at the University of Arizona before 1963 who detected that reaction time to a light patch, which changed in size and intensity throughout his experiment, decreased as intensity increased, but that the relationship was not independent of area. Both Pokorny's and Hufford's studies could lead to the conclusion that perception time is related to the size variable.

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[18] Joel Myron Pokorny, "The Effects of Target Area and Luminance on Grating Acuity," Dissertation Abstracts, 28:5219-5220-B, April-June, 1968.

[19] Lyle Edward Hufford, "Reaction Speed as a Function of Visual Stimulus Size and Retinal Area," Dissertation Abstracts, 24:1253-1254, July-September, 1963.

Differences in perception relating to changes in screen size for motion picture projection were noted as a side effect of investigations by D. John Patrick Guckin[20] at Pennsylvania State University in 1966 when he attempted to show that 8 mm. and 16 mm. film produced the same perceptual experience for the viewer. He did not, however, attempt to scientifically explain the screen size-effect that was detected.

In some other studies with related aspects, screen size and viewer distance relationships are noted but are not satisfactorily defined. For example, J. C. Reynolds[21] at Indiana University in 1968 attempted to equate viewer distance from the screen to induced anxiety level, and O. S. Rich[22] compared large screen versus standard screen television usage in education studies at Pennsylvania State University. Results of the first of these showed no significant relationship between anxiety level and distance from the screen.

The second study showed no significant difference in achievement as a result of large screen or small screen viewing. But, in both of these experiments variables of subject assignment and stimulus content were not controlled

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[20] John Patrick Guckin, "A Psycho-physical Analysis of Marginal Linear Perception and Image Resolution in Eight Millimeter and Sixteen Millimeter Silent Motion Picture Treatments with a Junior High School Population," Dissertation Abstracts, 29:3617-A, March-June, 1967.

[21] James Conrad Reynolds, "The Effect of Viewer Distance on Film Induced Anxiety," Dissertation Abstracts, 29:3341-A, April-June, 1969.

[22] Owen Sterling Rich, "A Study of Comparative Effectiveness and Acceptance of EIDOPHOR Large Screen Television for College Level Instruction," Dissertation Abstracts, 24:3235, January-March, 1964.

in a way that would allow for a scientific examination of subject distance and stimulus size effects.

In a theoretical study of visual perception using visual masking, it was noted by Mayzner[23] that distance of the subject from a television screen did not affect the masking effect on serially presented data at high data input rates. In the same study Mayzner showed that a change in stimulus size on the television screen did affect the masking phenomenon.[24] This would seem to be incongruous. If a change of visual angle of the projected stimulus due to a stimulus size change affects masking phenomenon, why are masking phenomena not affected by a change in visual angle represented by added distance between the subject and the stimulus? Kahneman reports in Information-Processing Approaches to Visual Perception, of the existing studies in visual masking, ". . . masking effects have never been assessed in terms of critical size."[25]

Stimulus size and distance relationships were, however, used by Merrill F. Elias[26] as independent variables in his work with identification of symbols

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[23] M.S. Mayzner and others, "Further Preliminary Findings on Some Effects of Very Fast Sequential Input Rates on Perception," Psychonomic Science, 7:281, March, 1967.

[24] Ibid., p. 282.

[25] Daniel Kahneman, "Method, Findings, and Theory in Studies of Visual Masking," Information-Processing Approaches to Visual Perception, ed. Ralph Norman Haber (New York: Holt, Rinehart and Winston, Inc., 1969), p. 94.

[26] Merrill F. Elias, "Speed of Identification of Televised Symbols as a Function of Vertical Resolution," Visual Simulation and Image Interpretation,

as a function of the number of scan lines on a television screen. By adjusting the subject's distance from the screen, Elias kept the apparent size of the symbol the same in order to test identification time for alphanumeric symbols comprising varying numbers of television scan lines. Elias was assuming that recognition time would remain the same if visual angle remained the same.

Conclusion

There are at least two definable areas of research which should be considered in discussing the use of visual material in television production. One area is the theoretical study of various aspects of communicating through the visual channel. The other area is that body of studies which investigates how to prepare visual materials for use in the visual media.

In theoretical study visual stimuli have been viewed at various luminances, angles, distances, and speeds of presentation. Studies have also investigated subject familiarity with stimuli content and the effects of interference of other visual stimuli and other perceptual channels. Stimuli have included alphabetical, numerical, and geometrical patterns as well as presence of varied luminances (flashes). Stimuli have been presented on motion picture and slide projection screens, television screens, flash cards, and tachistoscopes. Throughout the theoretical literature there appears to be consistently noted effects of viewer distance on perception time. Those effects were not identified

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ed. William D. Bliss, Human Factors Laboratory Task No. 7885-21, Technical Report NAVTRADEVCEN IH-153 (Orlando, Fla.: Naval Training Device Center, 1969), p. 29.

as a particular area of concern, nor were they carried over into the existing literature, in discussing preparation of visual materials for presentation in any scientific manner. The object of the present study was to establish that a measurable Distance and Size Perception-Time Effect does exist and to examine some of its effects on a defined television viewer under specified controlled conditions. It was the intention of this study to call attention to two factors which require greater attention than they are presently afforded in the preparation of visuals for television, viewer to screen probable distances and screen sizes.

Chapter 2

THE EXPERIMENT

This study was designed to show that perception time of a written message on a television screen is affected by a change of the screen size on which the message is presented or by a change in distance of the viewer from the screen.

This chapter discusses selection of the method and explains the experimental design. A description of materials and equipment and their use is given and the preparation and administration of stimuli are detailed. Selection of subjects and administration of the tests are then explained along with the methods used to handle and analyze the data.

SELECTION OF THE METHOD

The experimental method was selected in order to quantitatively demonstrate that set size and subject distance to screen affect the time required for visual recognition of designated written stimuli.

A post test-only control group type design was selected for this experiment. The sources of internal invalidity such as history, motivation, testing, instrumentation, regression, selection, mortality, interaction of selection and motivation were positively controlled in this design. The control of external sources of invalidity was slightly more positive than that in some other true experimental designs.

The design controlled for testing as main effect and interaction, but unlike the Solomon Four-Group design, it did not measure them. "However, such measurement is tangential to the central question of whether or not X" (the exposure of a group to the experimental variable or event) "did have an effect."[27]

Therefore, although the Solomon Four-Group design would provide more information on the observed effect, it was not considered worth the more than double effort that would be required to use it to conduct this experiment. The primary goal of this experiment was to show that X does have a measurable effect. The posttest-only control group design is very effective in this application.

The object of this experiment was to detect and record changes in recognition time of short sentences presented visually on a television screen. The experiment was designed to eliminate as many unwanted variables as possible and use varied set sizes and viewer distances as devices to effect change in the dependent variable: recognition time. Results showing that recognition time was relatively constant for a given apparent stimulus size and that a change in recognition time could be achieved by changing apparent size by adjusting set size or viewer distance, would substantiate the main hypotheses as stated.

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[27] Donald T. Campbell and Julian C. Stanley, Experimental and Quasi-Experimental Designs for Research (Chicago: Rand McNally & Company: 1971), p. 25.

THE EXPERIMENTAL DESIGN

A pre-test and four experiments were conducted. See table 1.

Table 1

Group Assignments to Experimental Conditions

Viewer Distance	Set Size			
	8-inch 20.32 cm	12-inch 30.48 cm	15-inch 38.10 cm	23-inch 58.42 cm
6 Feet or 1.83 m.	GP1 GP4	GP2	GP3 GP4	GP1 GP4
9 Feet or 2.74 m.		GP2		
11.25 Feet or 3.43 m.			GP3	
17.25 Feet or 5.26 m.				GP1

Pre-Test

The group 1 test set-up was performed on 5 subjects (not a part of the sample) in order to make certain that physical aspects of test operation were in order and that testing would run smoothly. This pre-testing also served as a training session for test conductor and test assistants. Scores from this test were not used in the analysis of data.

Group 1

Group 1 was the major test and used 20 subjects who were randomly selected[28] and randomly assigned[29] to test conditions in each possible order of presentation sequence. Experimental conditions were randomly administered to all groups to reduce the possibility of score biases due to factors such as experience gained in the test, potential varied degrees of difficulty related to recognition of specific stimuli sentences and subject fatigue.

Group 1 participants viewed 3 series of similar sentences under varied conditions. Nine sentences were seen on an 8-inch (20.32 cm.) screen at 6 feet (1.83 m.) 9 sentences on a 23-inch (58.42 cm.) screen at 6 feet (1.83 m.) and 9 sentences on a 23-inch (58.42 cm.) screen at 17.25 feet (5.26 m.)

Participants' verbal responses to the visual stimuli were recorded to indicate at which exposure of each stimulus the subject completed verbalization of the message.

Group 2

Six subjects were randomly assigned to 2 experimental conditions. Subjects viewed 3 groups of similar sentences on a 12-inch (30.48 cm.) screen. Some sentences were observed from a 6 foot (1.83 m.) distance and some from a 9 foot (2.74 m.) distance.

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[28]Method of randomizing subject selection is detailed under SUBJECT SELECTION page 35.

[29]Random assignment to test conditions and random administration of tests is detailed under CONDUCTING THE EXPERIMENT page 36.

Viewing the 12-inch (30.48 cm.) screen from 9 feet (2.74 m.) gives the same apparent image size as 6 feet (1.83 m.) from the 8-inch (20.32 cm.) screen in the Group 1 experiment. The same video tape used for Group 1 was used for Group 2, as was the same scoring method.

Group 3

Six subjects were randomly assigned to 2 experimental conditions. Subjects viewed 3 groups of similar sentences on a 15-inch (38.10 cm.) screen. Some sentences were observed from a 6-foot (1.83 m.) distance and some from an 11.25-foot (3.43 m.) distance. Viewing the 15-inch (38.10 cm.) screen from 11.25 feet (3.43 m.) gives the same apparent image size as 6 feet (1.83 m.) from the 8-inch (20.32 cm.) screen in Group 1 and 9 feet (2.74 m.) from the 12-inch (30.48 cm.) screen in Group 2.

The same video tape used for Group 1 and Group 2 was used for Group 3, as was the same scoring method.

Group 4

Group 4 tests were performed as a posttest. Based on the results of the Group 1 experiment, predictions were made as to expected results for the posttest. Eleven subjects were randomly assigned to 3 series of similar sentences under varied conditions. Nine sentences were viewed 6 feet (1.83 m.)[30] from a

[30] The 6-foot distance for viewing this test was selected based on findings by L. C. Jesty. For the 625-line British system viewer preferred distance was 5-1/2 times picture height. Recognizing that there are technical differences between the British and American systems (625-line, 25 frames per second: 525-line, 30 frames per second) which might affect quality and preferred viewing distance,

23-inch (58.42 cm.) screen. Nine sentences were viewed 6 feet (1.82 m.) from an 8-inch (20.32 cm.) screen. Nine sentences were viewed 6 feet (1.83 m.) from a 15-inch (38.10 cm.) screen.

The same video tape and scoring method were used as for the previous groups.

PHYSICAL ARRANGEMENT OF EQUIPMENT

Four TV monitors were placed on a low laboratory table and shimmed and leveled so that the center of each screen was 26 inches (66.04 cm.) from the floor. Screen sizes were measured horizontally. Figure 1 shows the sets

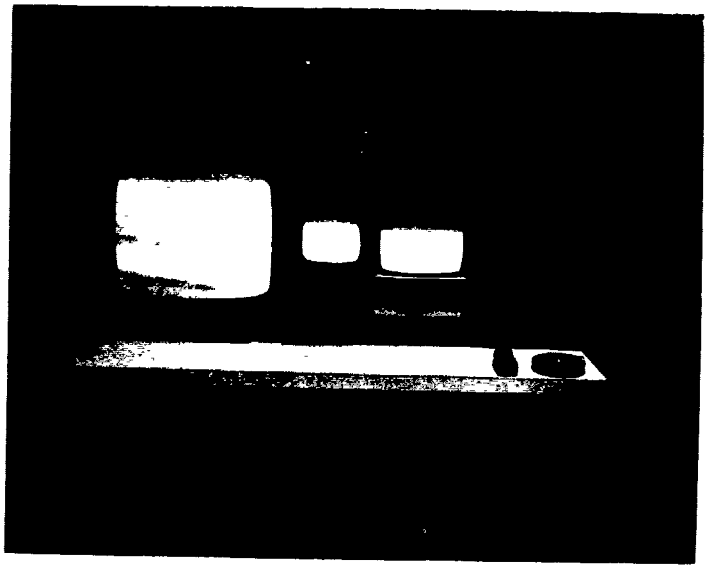

Figure 1

Television Sets for Stimulus Presentation

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this guideline was, nevertheless, used to establish 6 feet as the closest to preferred viewing distance for the middle sized screen in testing Group 4. See L. C. Jesty, "The Relation Between Picture Size, Viewing Distance, and Picture Quality," The Proceedings of the Institution of Electrical Engineers, 105:432, September, 1958.

which, from left to right were a 23-inch (58.42 cm.) CONRAC Model CVA 3 23 Covina, California, 120 v 50/60 Hz 190 watts; 8-inch (20.32 cm.) CONRAC Model CNB 8 Glendora, California, 117 v -50/60 Hz 130 watts; 12-inch (30.48 cm.) GE Closed Circuit Television Model 4TH31B1 -968, 120 volts AC-60 cy. 50 watts; and a 15-inch (38.10 cm.) CONRAC Model CVA 15 Glendora, California, 117 v 50/60 cy. 190 watts.

The room was 16 feet (4.88 m.) wide and 25 feet (7.62 m.) long. Lines were placed on the floor of the room running the full 25 feet perpendicular to the face of each television monitor and through the center line of the screen.

A cross grid was then made with masking tape on the floor marking a cross at 6 feet (1.83 m.) from the face of each monitor, and then additionally 9 feet (2.74 m.) from the face of the 12-inch (30.48 cm.) set, 11.25 feet (3.43 m.) from the face of the 15-inch (38.10 cm.) set and 17.25 feet (5.26 m.) from the face of the 23-inch (58.42 cm.) set.

An executive office chair, plastic covered with padded seat, back and arms was fitted with elastic bands at the floor, see Figure 2. One band was stretched from the foot of the left front leg to the foot of the right rear leg. Another, from the right front leg to the left rear leg. This formed a cross which intersected at the floor level directly beneath the center of the chair seat and could be used as a reference point on the masking tape grid lines for positioning the chair exactly the same from subject to subject.

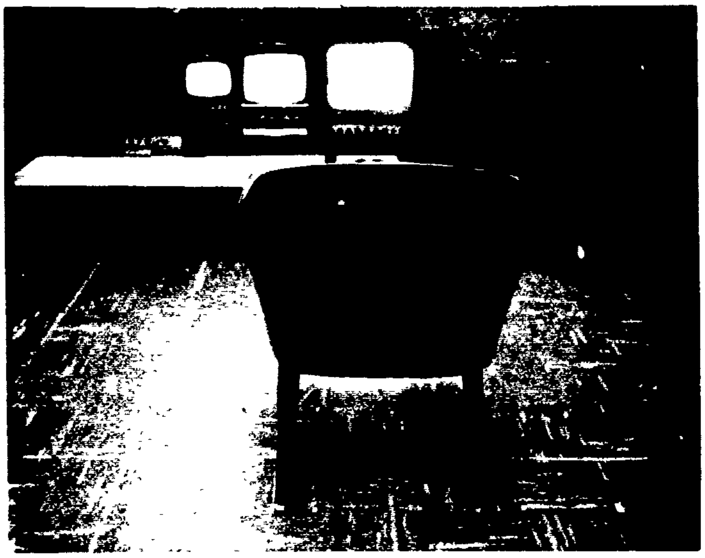

Figure 2

Seat with Cross-bands at Floor

The testing room, Figure 3, was lighted at 4 to 6 foot-candles (43.06 to 64.58 lumen/m.^{2}) measured from the center of the television screens, by one table lamp with a 60-watt bulb and a translucent shade. The lamp was placed 6 feet (1.83 m.) from the nearest television screen and at an angle to the right of the subject in such a location that no reflections were visible on the television screens from any of the test positions.

The video tape recorder was placed on a table at the back of the room to the subjects left. It was interconnected to all 4 monitors through a switcher and cables. The switcher permitted directing the tape output to any one of the 4 television monitors at will.

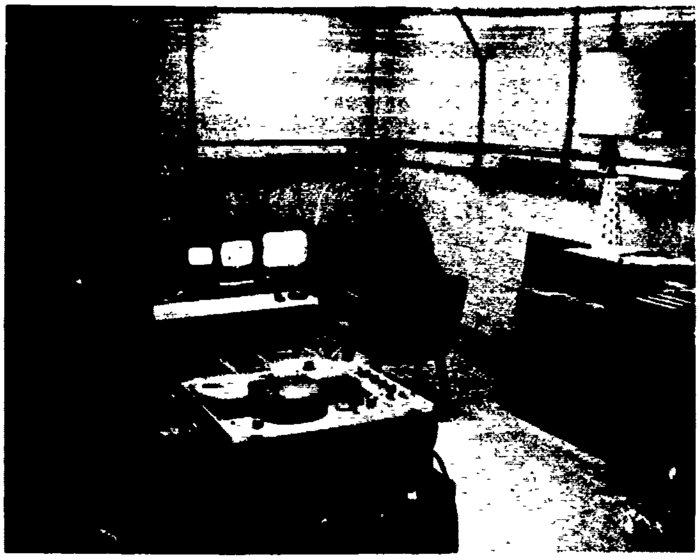

Figure 3

The Testing Room

Prior to testing, the experimental tape was run to a typical stimulus sentence "find one sweet flower", Figure 4, and stopped. This still picture was then switched from one screen to another and contrast between screens was compared and adjusted by eye by the test conductor and the test assistant. When contrast was judged to be similar on all sets by these two observers, a Spectra Exposure Meter (Model S-500 no. 6586 Photo Research Corp., Hollywood, Calif.) was used to measure brightness of each screen. The meter was held 6 inches (15.24 cm.) from the center of each screen and the previously mentioned still picture was switched from one screen to the next adjusting brightness to an output of 24 foot-candles (258.34 lumen/$m.^2$)

This procedure was repeated prior to running each set of subjects through the test.

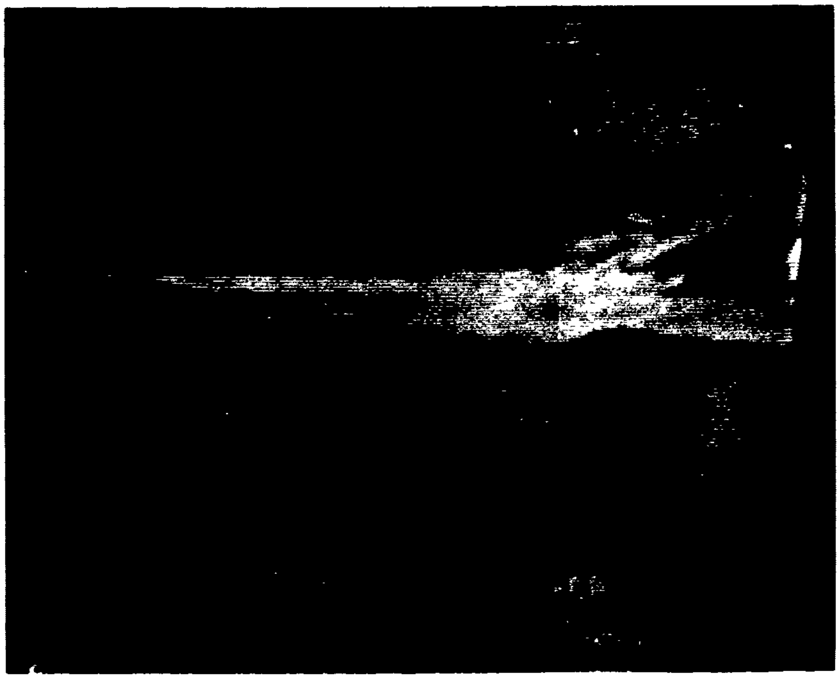

Figure 4

Typical Stimulus Sentence

PREPARATION OF STIMULI

Sentences were presented on television receivers using a 1-inch (2.54 cm.) video tape and television monitors of various screen sizes. The video tape was recorded from a 16-mm. motion picture film.

Filming the Background

Breaking surf background was selected to provide a visual "noise"[31] background in order to reduce the effect of after-image on stimulus recognition

[31]George Sperling, "Successive Approximations to a Model for Short-Term Mem y," Information-Processing Approaches to Visual Perception, ed. Ralph Norman Haber (New York: Holt, Rinehart and Winston, Inc., 1969), p. 34.

time. The surf was a realistic background that might be used in television programming, but at the same time, being composed of scattered bits of light and dark (breaking waves), acted as visual noise which was much more effective interference than a homogeneous field.

> Because visual information is usually available to the perceptual system after termination of a light stimulus, especially a bright one, physical duration is seldom an accurate measure of "perceptual duration." The physical and perceptual durations may become more alike, however, when the stimulus word is followed by a visual noise pattern instead of by the usual homogeneous, unpatterned field. Sperling (1960) has shown that such a pattern reduces the information obtained from a brief visual display when it follows the display immediately or with a delay up to 500 msec. The noise pattern apparently terminates post-stimulatory processes thereby shortening the perceptual duration; an unpatterned field (provided it is not too bright) does not.[32]

A breaking surf on a cloudy day with a soft drizzle of rain was used. The background was shot on three 100-foot rolls of ECO 7255 Kodak 16 mm. motion picture film looking north eastward on the beach at Brigantine, N.J. at the foot of 24th street. The camera was an Ariflex 16 mm., and settings were at f 5.6, 24 f.p.s. at 1/50 of a second.

Super-Imposing Stimulus Sentences

Stimulus sentences were typed on white bond paper. Each sentence was centered on a 8-1/2 x 11-inch sheet using 14 point IBM EXEC type with proportional spacing. Sentences contained words with known frequencies of usage in an attempt to level out recognition time effects relative to subject familiarity

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[32] Bertram Scharf, Harold S. Zamansky and Roger F. Brightbill, "Word Recognition with Masking," Perception and Psychophysics, 1:110, April, 1966.

with stimulus words.[33] Thorndike and Lorge[34] provided the list of words (Appendix B) from which visuals were prepared to display white letters on a dark background. White on dark was selected as being the most prevalent usage in television advertising after having taken a brief census of television advertising which incorporated written messages over the picture area (Appendix C).

Each sentence was photographed on Kodak high contrast 35-mm. negative. A Mamaya Sekor camera was selected using a 135-mm. lens with extension tubes and an exposure of f4 at 1/15 second. Uniform, flat lighting was provided by one 1000-watt quartz lamp 5 feet (1.52 m.) from the surface to be photographed and approximately 30 degrees to the right of the camera position.

The 100-foot background rolls were rewound and loaded one at a time into a Bolex 16-mm. motion picture camera. The high density negatives containing stimulus sentences were individually placed on a flourescent light table and all areas but the sentence were masked with black cloth. The only light source was that which was coming through the stimulus sentence. Prior to exposing the pre-exposed background footage an exposure test was run using an equivalent ASA (tungsten 25) rated black and white negative film from f4 to

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[33] R. L. Soloman and L. Postman, "Frequency of Usage as a Determinant of Recognition Thresholds for Words," Journal of Psychology, 43:195-201, March, 1952.

[34] E. L. Thorndike and I. Lorge, The Teacher's Word Book of 30,000 Words (New York: Columbia University, 1944), passim.

f11 at 1/2 second exposure. F8 was selected and 9 sentences selected at random from a shuffled deck of negatives were exposed on each of the 100 foot exposed background films.

The film was advanced 72 frames and 1 frame of the first sentence was exposed. The film was advanced 24 frames and 2 frames of the stimulus sentence were exposed. The film was advanced 24 frames and 3 frames of the stimulus sentence were exposed. This procedure continued up to 12 frames of stimulus sentence exposure. Then the film was advanced 72 frames and the entire procedure begun again for the next stimulus sentence. Figure 5 graphically depicts

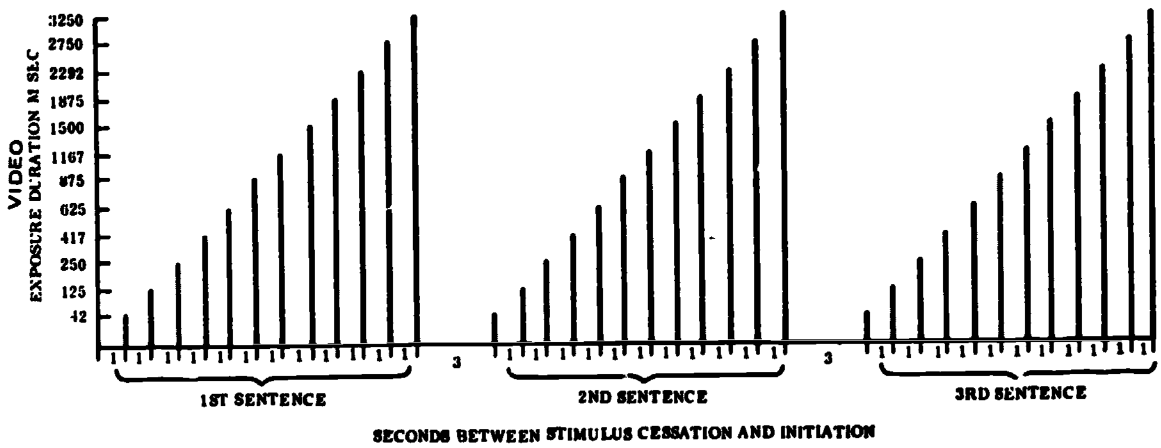

Figure 5

Pattern of Stimulus Exposure

the pattern of stimulus exposure. This exposure pattern provided a range of successive exposures from approximately 41.667 msec. to 500 msec. for each 18-letter sentence. A lens cap was placed over the lens during intervals between stimulus exposure to insure against accidental exposure of the background film.

Three 100-foot rolls of film were prepared in this manner, processed and then spliced together. The film was transferred to video tape in Temple University's Television Services Laboratory using a Sony EV-2-30 Video Tape Recorder. This same recorder was used in presenting the stimuli while conducting the experiment.

Range of exposure times were selected based on George Sperling's findings that letters are scanned at a rate of one letter per 10 to 15 msec. confirmed in studies by B. Scharf, H.S. Zamansky, and R.F. Brightbill.[35] Sentences used in this experiment were made up of 18 letters. This would equal 180 to 270 msec., according to Sperling's figures, making recognition possible beginning with the third or fourth stimulus exposure. It must be noted, however, that these figures do not specifically account for any Distance and Size Perception-Time Effect.

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[35]Bertram Scharf, Harold S. Zamansky and Roger F. Brightbill, "Word Recognition with Masking," Perception and Psychophysics, 1:112, April, 1966.

SUBJECT SELECTION

The subjects were selected from a GE Space Division Valley Forge Operation personnel list (Appendix D) which breaks employees down by department. Each department has a mixture of employee types, each of whom was assigned a job description code. The code suffix -101 means engineering personnel. Total number of personnel on the list used was 1852. Total number of engineering pe nnel was 644. Only engineering personnel were selected in order to establish homogeneity within the sample. Each employee additionally had a 5 digit pay number. The first two digits of the pay number indicate alphabetical placement of the last name of the employee in the total Division employee list. The remaining 3 digits are assigned or re-assigned randomly when the employee is hired.

In order to select a random sample of engineers from this list the last digit of the pay number was used. The first "1" that showed up in the 5th position of the pay number for a name that was coded - 101 (for engineer) was selected. The next selection was the first "2" that showed up in the last position of the pay number under the same conditions, and so forth up to and including "0" which made up the first 10-subject group. This procedure was repeated to create 7 10-subject groups. After going through the list one time and not filling the required sample number the list was entered again from the beginning, this time starting with the next number in sequence (which happened to be "2"). The first "2" encountered was the same as the first time through the list, so this name was skipped and the next "2" that appeared was pulled and so on through the list for the remaining number of required samples.

Each of the 70 selected individuals was then called on the telephone and interviewed using the same questions and order of questioning (Appendix E). All but one subject replied that he was willing to participate.

Names of the willing subjects were typewritten on slips of paper, folded, and placed in a small box. A table of random numbers should have been used to provide a better method for randomization. Names were pulled from the box and assigned a date and hour to report for the experiment. Subjects were called again on the telephone. Of the initial 69 willing subjects only 48 were able to participate at the assigned time. Of the 48 able to participate and given specific times to report for testing, 43 attended and participated in the experiment.

CONDUCTING THE EXPERIMENT

Each subject was assigned a time to report to the testing room. Subjects were spaced at 15 minute intervals in the morning hours between 8:30 AM and 11:30 AM during the last week of December, 1971, and the first of January, 1972. There was a written test room and a display room. Early arrivers were asked by a sign on the door to wait outside the testing room. Those who had completed the perceptual portion of the experiment were given a questionnaire (Appendix F) to fill out in the written test room. Two desks with office type goose neck flourescent desk lamps were provided for subjects to use while filling out the questionnaire.

Prior to starting each group through the test, score sheets were made up for the number of subjects to be tested in that group. One set of score sheets was worked to provide a score sheet indicating each possible sequence of stimuli presentation within that group. After each possible order of presentation was identified on a score sheet, similar sets of score sheets were marked until there was one score sheet so marked for the number of subjects in that group. All of these marked score sheets were placed in a desk and shuffled. One score sheet was given to each subject as he entered the test room thus randomizing the sequence of stimuli presentation within groups.

A second score sheet was then annotated for stimuli sequence to match the one from the deck and given to the assistant test conductor, and, the subjects name was written on both score sheets.

It is recognized that randomization by use of random number tables tends to be more nearly random than picking names from a box or shuffling a deck, and the more scientific method would be preferred in future studies. It was necessary, in this case, to use less time consuming methods to randomize subject assignment to group, sequence of photographing sentences, and assignment of subjects to test conditions in order to meet the pre-established test schedule.

Each subject was brought into the display room individually. The test conductor and one assistant were present. The test conductor seated the subject and explained the test to the subject using the same words for each subject

(Appendix G). The video tape was then shown under conditions prescribed according to group assignments. Conditions peculiar to each group were randomly ordered in their assignment to subjects within each group to equalize any effects which might be operating as a result of conditions other than those to be measured, i.e. differences in recognition time related to peculiarities of the individual sentences being presented, interaction of sentences with background picture, learning effects or subject fatigue.

The video tape was operated by the test conductor and both test conductor and test assistant, Figure 6, scored subjects on the score sheet provided. (Appendix H.)

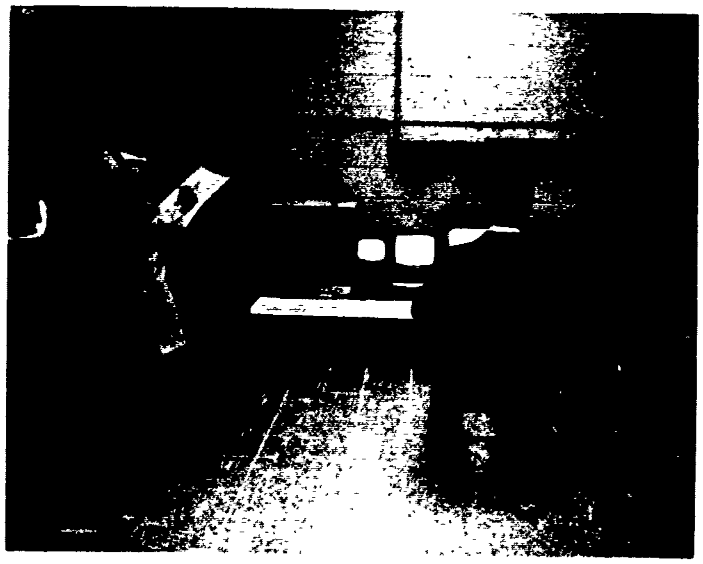

Figure 6

Test Assistant and Subject

The test conductor and test assistant were required to judge at which presentation the subject completed a verbal report of the message presented on the screen. Presentation was represented by a number from 1 to 12. The number represented elapsed time of stimulus exposure measured in motion picture picture frames.

Test conductor and assistants practiced on subjects not included in the experiment prior to conducting the experiment in order to establish an acceptable level of competence. Nine consecutive sentences scored with no discre ancy greater than 1 was considered acceptable.

After seeing the video tape portion of the experiment each subject was given the questionnaire, instructed to fill it out in the written test room and told to leave it on the desk when he left.

The video tape was then rewound, the previous subject's written test was removed from the desk in the written test room, and the next subject was requested to come in and be seated.

ANALYZING THE DATA

All questionnaire data were put on IBM cards and frequency tables were computed on a Temple University SPSS computer program.

Criteria used for scoring exposure recognition times were established in order to put the data into a form which could be handled efficiently on IBM cards.

The total elapsed time for each subject was calculated through the end of the exposure during which the subject completed his response. Total elapsed time is the summation of all of the exposures up to and including the exposure during which recognition was recorded.

Periods of plain background picture between stimulus presentations are not included in this figure. The figure represents the total stimulus elapsed time through the end of the exposure during which the test conductor or test assistant considered complete recognition to occur.

Calculations were made in msec. using the base number of 41.667 msec. to represent one motion picture frame. Calculations were done in duplicate to three decimals by two separate individuals and then rounded to the nearest millisecond. Final results by both calculators were then compared and corroborated. A table was constructed to show cumulated exposure times for responses from 1 to 12 as recorded on the data sheets. Additionally, a number was assigned to each possible score which represents what multiple of 41.667 that answer represents. See Table 2. The maximum physical length of that multiple is two digits so that number was recorded on the IBM data cards instead of the score in milliseconds in order to reduce the data handling complexity. The score in milliseconds can be derived at any time by simply multiplying the IBM score number by 41.667.

In analyzing the data, where test conductor and test assistant data disagreed by 1 digit, the highest digit was used to make the data as conservative as possible. Where the test administrators' data disagreed by 2 digits or more a "no response" was recorded in the exposure column because this wide a

Table 2.

Subject Scores, Mathematical Equivalents, and Msec. Equivalents

Subject Scores	Mathematical Equivalent for Calculation Purposes	Rough[a] Msec. Equivalent
1	1	42
2	3	125
3	6	250
4	10	417
5	15	625
6	21	875
7	28	1167
8	36	1500
9	45	1875
10	55	2292
11	66	2750
12	78	3250
99	NR	NR

[a]41.667 msec. equals 1 motion picture frame. Mathematical equivalent x 41.667 = approximate total exposure time in msec. Motion picture projection of one frame technically provides a shorter period of actual exposure than this when shutter movement and mechanical processes are considered. Additional technical considerations might be mentioned concerning the 24 frame-per-second rate of motion picture projection and the 30 frame-per-second rate of the video into which this film was converted, but for purposes of this experiment the exposure will be considered 41.667 msec. per frame. This figure provides a workable base figure accurate enough for the purposes of this experiment. The reader is reminded that the actual measure was of total elapsed time.

discrepancy was considered to represent an error on the part of one of the test administrators. Since there is no way to ascertain which administrator's data was in error, it was considered better to discard that data and calculate means on a lesser size of sample to keep the maximum error smaller.

This resulted in discarding 6.63% of the recognition time data. Maximum error, however, was thus established as plus or minus 500 msec. for a discrepancy of 1 between test conductors at the top of the scale. This is so since an error of 1 by a test conductor at 12 frames would equal 12 times 41.667 msec. above or below actual score.

Subject information was then tabulated and subjected to one-way analysis of variance in Temple University's Computer Center using the BMDOIV computer program.[36] Data were transcribed from raw data sheets to IBM format sheets by an assistant. Cards were then punched and verified from the IBM format sheets by the test conductor. After IBM cards were punched and verified, the verified deck of cards was checked against raw data sheets. The purpose of this check was to examine the assumption that all data contains some degree of potential transcription error and that potential error should be reported in some fashion. The results of this check verify that assumption. Out of 3397 entries in the verified IBM deck 6 discrepancies with raw data were identified. Four errors were errors of entry on the IBM format sheets and two errors were digits misread on the IBM format sheets in key punching information on cards and misread again in verification.

[36] W. J. Dixon (ed.), Biomedical Computer Programs (Berkeley: University of California Press, 1968) p.p. 486-494.

These two errors due to misreading might have been avoided if a different person had verified the deck or if a greater time lapse had been allowed between the key punching operation and the verification operation which in this case were performed consecutively on the same evening.

The magnitude of this transcription error, though small, is reported here at 0.17%.

It is apparent that activities of data transcription are a potential source of error in data and call for further standardization of practices and reporting methods. Transcription errors, for example, are not mentioned in Standards for the Publication of Statistical Data.[37]

Randomization was employed in every aspect of subject selection, assignment, stimulus production, and testing throughout this experiment to attain maximum validity. After the data for Group 1 were analyzed and the relationship of set size and subject distance to recognition time was expressed in a formula, that formula was used to make a prediction for Group 4 results. These predictions were compared with actual Group 4 results. These two sets of data were shown to concur to assure the validity of the results obtained during testing.

To enhance reliability a test assistant was present during all testing to record results concurrently with the test conductor.

[37] Standards for the Publication of Statistical Data, Exhibit C, Circular A-46 (Washington: Executive Office of the President, Bureau of the Budget, 1964), p. 2.

Chapter 3

FINDINGS, CONCLUSIONS AND RECOMMENDATIONS, AND SUMMARY

Forty-three engineers of the General Electric Company Space Division in Valley Forge, Pennsylvania were tested for visual perception of short sentences presented on television screens. Recognition time data were gathered for short sentences presented at varying distances from subjects and shown on different screen sizes.

Recognition time appeared to decrease as the subject was moved closer to the television screen for those distances tested. Recognition time appeared to decrease as the screen size was increased for the range of screen sizes tested.

This chapter details the findings of this experiment. Conclusions are based on these findings and recommendations are made for further study. A summary of this study is then provided.

FINDINGS

The findings showed that a Distance and Size Perception-Time Effect appeared to be operating on the subjects and sentences under the conditions in this experiment.

Results of the subjects' scores, were subjected to a one-way analysis of variance. Analyses were reviewed with respect to the hypotheses stated in Chapter 1.

A rule-of-thumb formula was derived to predict recognition time change related to the Distance and Size Perception-Time Effect as observed in the subjects in this experiment. This formula was used to predict the scores that should have been recorded for Group 4 of this experiment. Predicted scores were compared with actual scores.

Subjects were analyzed with respect to answers to the posttest questionnaire. An attempt was then made to relate the subject analysis with the analysis of scores in order to provide possible implications of the Distance and Size Perception-Time Effect on standard viewing practices of the subjects.

Analysis of Scores

Raw scores were converted to a mathematical equivalent of msec. (see Table 2, page 41) and analyzed using the Temple University computer program for one-way analysis of variance. The mathematical equivalent recognition time scores for group 1, which consisted of 20 people, provided a mean of 47.016 msec. for subjects 6 feet (1.83 m.) from an 8-inch (20.32 cm.) screen, 27.170 for subjects 6 feet (1.83 m.) from a 23-inch (58.42 cm.) screen and 48.078 for subjects 17.25 feet (5.26 m.) from a 23-inch (58.42 cm.) screen. A one-way analysis of variance for all treatments of Group 1 data showed that the between groups sum of squares was 5333.629 with 2 degrees of freedom and a mean square of 2666.815. Within groups sum of squares was 9795.435 with 52 degrees of freedom and a mean square of 188.374. The F ratio was 14.157 (Table 3), significant at the 0.01 level.

Table 3

Group 1 all Treatments

Treatment	6' (1.83 m.) from 8" (20.32 cm.) TV	6' (1.83 m.) from 23" (58.42 cm.) TV	17.25' (5.26 m.) from 23" (58.42 cm.) TV
Sample Size	15	20	20
Mean	47.016	27.170	48.078
Standard Deviation	13.404	9.129	17.315
F Ratio		14.157[a]	

[a]Significant at the 0.01 level.

This indicates that a change in recognition time exists for these subjects and stimulus sentences relative to the television screen size and the viewers' distance from the screen.

Effect of increased screen size. To demonstrate the stated hypothesis, Group 1 scores had to demonstrate that increased screen size with viewer distance held constant would result in reduced recognition time. The mean recognition time score for the initial treatment group was 47.016. This mean recognition time score was drastically reduced to 27.170 by increasing the set size from 8 inches (20.32 cm.) to 23 inches (58.42 cm.).

A one-way analysis of varia·.ce performed on these two sets of scores showed that the between groups sum of sq.ares was 3375.805 with 1 degree of freedom and a mean square of 3375.805. The within groups sum of squares was 4098.909 with 33 degrees of freedom and a mean square of 124.209. The F Ratio was 27.178 (Table 4), significant at the 0.01 level.

Table 4

Group 1 Distance Constant Set Size Increased

Treatment	6' (1.83 m.) from 8" (20.32 cm.) TV	6' (1.83 m.) from 23" (58.42 cm.) TV
Sample Size	15	20
Mean	47.016	27.170
Standard Deviation	13.404	9.129
F Ratio	27.178[a]	

[a]Significant at the 0.01 level.

Effect of Increased Distance

To demonstrate the distance effect on recognition time, Group 1 subjects were moved away from the 23-inch (58.42 cm.) set to a distance of 17.25 feet (5.26 m.). This distance subtends a visual angle with the screen and image to make their apparent size the same as for the first condition described; 8-inch (20.32 cm.) screen at 6 feet (1.83 m.). Recognition time scores then jumped from a mean of 27.170 at the 6-foot (1.83 m.) distance to a mean of 48.078 at the 17.25-foot (5.26 m.) distance.

A one-way analysis of variance performed on these two sets of scores showed that the between groups sum of squares was 4371.445 with 1 degree of freedom and a mean square of 4371.445. The within groups sum of squares was 7280.0245 with 38 degrees of freedom and a mean square of 191.580. The F Ratio was 22.818 (Table 5), significant at the 0.01 level.

Table 5

Group 1 Set Size Constant Distance Increased

Treatment	6' (1.83 m.) from 23" (58.42 cm.) TV	17.25' (5.26 m.) from 23" (58.42 cm.) TV
Sample Size	20	20
Mean	27.170	48.078
Standard Deviation	9.129	17.315
F Ratio	22.818[a]	

[a]Significant at the 0.01 level.

Effect of constant visual angle. If the visual angle of the stimulus is the same for the first condition and for the last, the apparent sizes of the two stimuli are the same to the viewer and according to the hypotheses being developed in this experiment should result in identical recognition time scores.

A one-way analysis of variance was performed on the scores for subjects 6 feet (1.83 m.) from the 8-inch (20.32 cm.) screen with a mean of 47.016, and those 17.25 feet (5.26 m.) from the 23-inch (58.42 cm.) screen with a mean of 48.078. Analysis showed that the between groups sum of squares was 9.676 with 1 degree of freedom and a mean square of 9.676. The within groups sum of squares was 8211.937 with 33 degrees of freedom and a mean square of 248.847. The F ratio was 0.039 (Table 6), not significant at the 0.05 level.

Table 6

Group 1 Visual Angle Held Constant

Treatment	6' (1.83 m.) from 8" (20.31 cm.) TV	17.25' (5.26 m.) from 23" (58.47 cm.) TV
Sample Size	15	20
Mean	47.016	48.078
Standard Deviation	13.404	17.315
F Ratio	0.039[a]	

[a]Insignificant at the 0.05 level.

The scores showed no significant statistical difference and, therefore, supported the hypothesis that a constant visual angle of the stimulus, regardless of actual size and distance, would result in a constant recognition time, for the parameters studied in this experiment.

Group 2 results. The subjects in Group 2 experienced a distance change only. Subjects viewed a 12-inch (30.48 cm.) screen at a distance of 6 feet (1.83 m.) and also at a distance of 9 feet (2.74 m.); a distance which subtends a visual angle similar to the 6-foot (1.83 m.) distance from the 8-inch (20.32 cm.) screen used with Group 1.

The 6-foot (1.83 m.) viewing distance produced a mean recognition time score of 35.604 and the 9-foot (2.74 m.) viewing distance a mean score of

41.216. These means indicate that the Size and Distance Perception-Time Effect is operating, but analysis of variance did not yield a statistically significant F number probably because of the very small sample size.

A one-way analysis of variance showed that the between groups sum of squares was 78.736 with 1 degree of freedom and a mean square of 78.736. The within groups sum of squares was 1950.676 with 8 degrees of freedom and a mean square of 243.835. The F ratio was 0.323 (Table 7), not significant at the 0.05 level.

Table 7

Group 2

Treatment	6' (1.83 m.) from 12" (30.48 cm.) TV	9' (2.74 m.) from 12" (30.48 cm.) TV
Sample Size	5	5
Mean	35.604	41.216
Standard Deviation	16.223	14.983
F Ratio	0.323[a]	

[a]Insignificant at the 0.05 level.

Group 3 results. Group 3 subjects also experienced only a distance change. They viewed stimuli 6 feet (1.83 m.) from a 15-inch (38.10 cm.) screen and 11.25 feet (3.43 m.) from a 15-inch (38.10 cm.) screen. The mean recognition time score 23.003 at the shorter distance and 40.643 at the longer distance support the hypothesis. Analysis of variance showed that the between groups sum of squares was 933.509 with 1 degree of freedom and a mean square of

933.509. The within groups sum of squares was 1667.384 with 10 degrees of freedom and a mean square of 166.738. The F ratio was 5.599 (Table 8). The difference between treatments was not significant at the 0.01 level but did prove significant at the 0.05 level. As in Group 2, the sample size was very small.

Table 8

Group 3

Treatment	6' (1.83 m.) from 15" (38.10 cm.) TV	11.25' (3.43 m.) from 15" (38.10 cm.) TV
Sample Size	6	6
Mean	23.003	40.643
Standard Deviation	6.596	17.028
F Ratio	5.599[a]	

[a]Significant at the 0.05 level.

Group 4 results. Group 4 was larger than Groups 2 and 3 consisting of 11 people. It was 9 subjects smaller than the main group, Group 1. Subjects in Group 4 viewed three different size sets, all from a 6 foot (1.83 m.) distance. The mean scores showed a reduction in recognition times as screen size increased. Mean scores were 45.488 for the largest screen, 25.390 for the middle sized screen and 20.887 for the smallest screen. An analysis of variance showed that the between groups sum of squares was 3774.526 with 2 degrees of freedom and a mean square of 1887.263. The within groups sum of squares was 2414.282 with 30 degrees of freedom and a mean square of 80.476. The F ratio was 23.451 (Table 9), significant at the 0.01 level.

Table 9

Group 4 All Treatments

Treatment	6' (1.83 m.) from 23" (58.42 cm.) TV	6' (1.83 m.) from 8" (20.32 cm.) TV	6' (1.83 m.) from 15" (38.10 cm.) TV
Sample Size	11	11	11
Mean	20.887	45.488	25.390
Standard Deviation	6.421	10.407	9.586
F Ratio		23.451[a]	

[a]Significant at the 0.01 level.

Mean scores of the groups viewing the largest and those viewing the smallest screen size were 20.887 and 45.488 respectively. An analysis of variance showed that the between groups sum of squares was 3328.626 with 1 degree of freedom and a mean square of 3328.626. The within groups sum of squares was 1495.388 with 20 degrees of freedom and a mean square of 74.769. The F ratio was 44.519 (Table 10), significant at the 0.01 level.

Table 10

Group 4 Large Versus Small Stimuli

Treatment	6' (1.83 m.) from 23" (58.42 cm.) TV	6' (1.83 m.) from 8" (20.32 cm.) TV
Sample Size	11	11
Mean	20.887	45.488
Standard Deviation	6.421	10.407
F Ratio	44.519[a]	

[a]Significant at the 0.01 level.

Mean scores of those viewing the smallest and the middle screen size were 45.488 and 25.390 respectively. An analysis of variance showed that the between groups sum of squares was 2221.653 with 1 degree of freedom and a mean square of 2221.653. The within groups sum of squares was 2001.990 with 20 degrees of freedom and a mean square of 100.100. The F ratio was 22.195 (Table 11), significant at the 0.01 level.

Table 11

Group 4 Small Versus Medium Stimuli

Treatment	6' (1.83 m.) from 8" (20.32 cm.) TV	6' (1.83 m.) from 15" (38.10 cm.) TV
Sample Size	11	11
Mean	45.488	25.390
Standard Deviation	10.407	9.586
F Ratio	22.195[a]	

[a]Significant at the 0.01 level.

Although the mean scores for subjects viewing the largest screen and the middle screen size appeared to be in direct concurrence with the hypotheses, results of an analysis of variance showed that the between groups sum of squares was 111.510 with 1 degree of freedom and a mean square of 111.510. The within groups sum of squares was 1331.186 with 20 degrees of freedom and a mean square of 66.559. The F ratio was 1.675 (Table 12), not significant at the 0.05 level.

Table 12

Group 4 Large Versus Medium Stimuli

Treatment	6' (1.83 m.) from 23" (58.42 cm.) TV	6' (1.83 m. from 15" (38.10 cm.) TV
Sample Size	11	11
Mean	20.887	25.390
Standard Deviation	6.421	9.586
F Ratio	1.675[a]	

[a]Insignificant at the 0.05 level.

Data failed to provide statistical validation of this point. This condition may be related to the small size of the sample.

Comparison Between Groups. To further examine the data, mathematical equivalent means were converted to actual means in msec. Group 1 took a mean of 1959 msec. to recognize stimuli on an 8-inch (20.32 cm.) screen at a distance of 6 feet (1.83 m.), a mean of 2003 msec. to recognize stimuli on a 23-inch (58.42 cm.) screen at a distance of 17.25 feet (5.26 m.) and a mean of 1132 msec. to recognize stimuli on a 23-inch (58.42 cm.) screen at a distance of 6 feet (1.83 m.).

Group 2 took a mean of 1717 msec. to recognize stimuli on a 12-inch (30.48 cm.) screen at a distance of 9 feet (2.74 m.), and a mean of 1484 msec. on a 12-inch (30.48 cm.) screen at a distance of 6 feet (1.83 m.).

Group 3 took a mean of 1693 msec. to recognize stimuli on a 15-inch (38.10 cm.) screen at a distance of 11.25 feet (3.43 m.), and a mean of 958 msec. to recognize stimuli on a 15-inch (38.10 cm.) screen at a distance of 6 feet (1.83 m.).

Group 4 took a mean of 1895 msec. to recognize stimuli on an 8-inch (58.42 cm.) screen at a distance of 6 feet (1.83 m.), a mean of 1057 msec. to recognize stimuli on a 15-inch (38.10 cm.) screen at a distance of 6 feet (1.83 m.), and a mean of 870 msec. to recognize stimuli on a 23-inch (58.42 cm.) screen at a distance of 6 feet (1.83 m.).

Plotting the mean scores, converted into msec. for all 4 groups, (Figure 7) produced a set of curves which are quite regular. The gap between scores for the most difficult perceptual tasks 6 feet (1.83 m.) from an 8-inch (20.32 cm.) screen, 9 feet (2.74 m.) from a 12-inch (30.48 cm.) screen, 11.25 feet (3.43 m.) from a 15-inch (38.10 cm.) screen, and 17.25 feet (5.26 m.) from a 23-inch (58.42 cm.) screen is 310 msec.

The maximum error in data was ± 500 msec. in establishing analytical methods. (Chapter 2 page 42). That represents a span of 1000 msec. Keeping that figure in mind, the gap of 310 msec. between four different groups of subjects appears quite small.

The one curve which slightly departed from the others in inclination was that for Group 2. It should be remembered that Group 2 was the smallest group, having only 5 members, and failed to exhibit statistical significance in the analysis

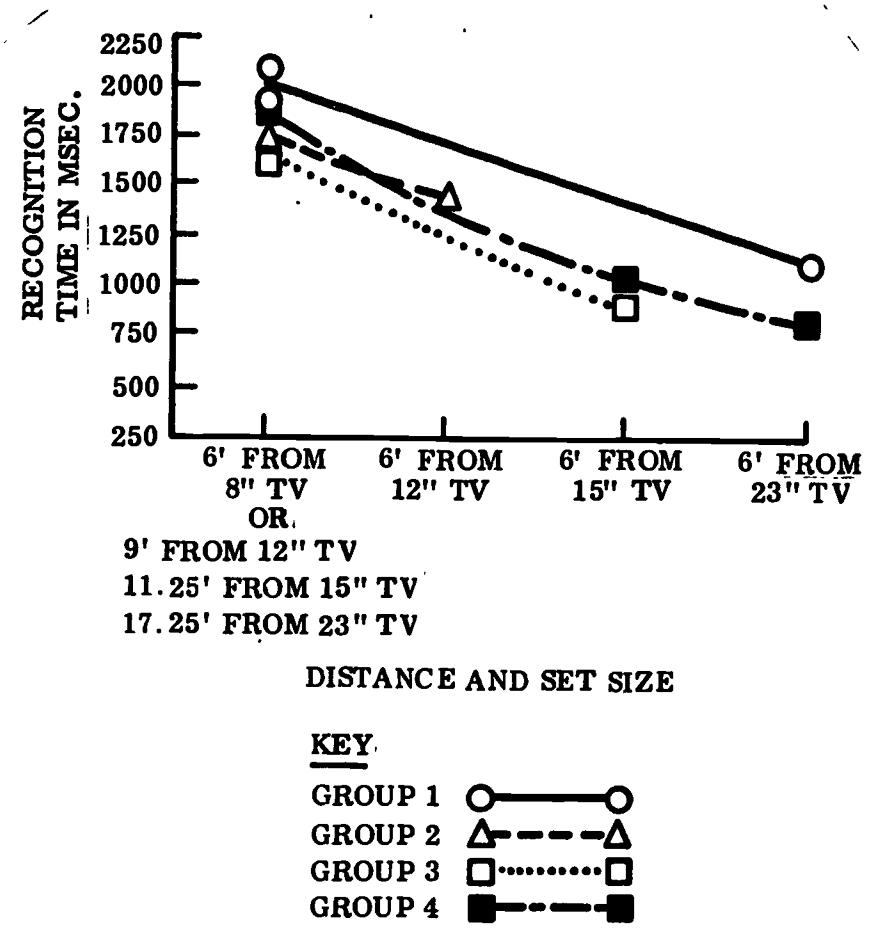

Figure 7

Mean Scores in Msec. for All Subjects Versus Distance and Set Size

of variance. Other possible causes of this departure were unmeasurable variations in testing which might have been operating unknown to the test conductor. Errors in scoring could also have affected the slope of this curve even though every precaution was taken to keep this kind of error from being carried into the final data.

Predicting Recognition Time Changes Due To The Distance and Size Perception-Time Effect[38]

For a given sentence of four words (as described in this experiment), using set sizes from 8-inch to 23-inch and viewing distances from 6 feet to 17.25 feet, a rule-of-thumb recognition time can be established for a change of set size or subject distance. Using Group 1 mean scores as a basis, and assuming the curve to be linear in accordance with the hypotheses being explored in this experiment, the longest recognition time was 2003 msec., and the shortest was 1132 msec. The 1132 msec. value was 56.51 percent of the longest recognition time. This indicated a 43.49 percent drop in recognition time related to screen size change or subject distance change in the range under study. Breaking this percent of drop into percent per foot of distance and percent per inch of screen size yields two estimators.

There was an 11.25-foot distance change from 17.25 feet to 6 feet. Therefore recognition time increased 3.87 percent with each foot of distance added between the television screen and the viewer, television screen size being constant.

There was a 15-inch difference in screen size between 8 inches and 23 inches. Therefore recognition time decreased 2.90 percent with each 1-inch increase in screen size, given the viewer distance remaining constant.

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[38] Calculations are made in the English system only, because, the purpose of this analysis is to relate experimental data to subject questionnaire data which was answered in the English system only.

Calculating recognition time change related to screen size. Given the 6-foot distance 8-inch screen score of Group 4 it should be possible to predict scores for the remaining two conditions. With the given score of 1895 msec. for subjects sitting 6 feet from the 8-inch screen use the formula:

Perception time for a given message when screen size is increased = (given perception time in msec.) -(given perception time in msec. x 2.90 percent x inches of increase in screen width).

Calculating for the 15-inch screen, (1895 msec.) -(1895 x 0.0290 x 7) = 1510 msec.

Calculating for the 23-inch screen, (1895 msec.) -(1895 x 0.0290 x 15) = 1071 msec.

The estimated change figure derived with the formula for the 15-inch screen was 1510 msec. Referring to the Group 4 curve of Figure 7, the actual score plotted on the curve for Group 4 was 1057 msec. This figure was 453 msec. from the estimated value. Referring back to the analysis of variance for Group 4's middle set size and large set size it should be noted that this comparison failed to meet a statistical level of significance. This was probably due to error in the methods or measurements of the experiment and indicated that this data point was most likely influenced by that error. Subtracting actual plotted value from estimated value gave 453 msec. That figure represents the actual maximum error observed in this experiment.

The estimated change figure derived for the 23-inch screen was 1071 msec. Actual plotted value was 870 msec. This estimated value was 201 msec. from the plotted value, well within the 453 msec. actual maximum error observed. This relationship is shown in Figure 8.

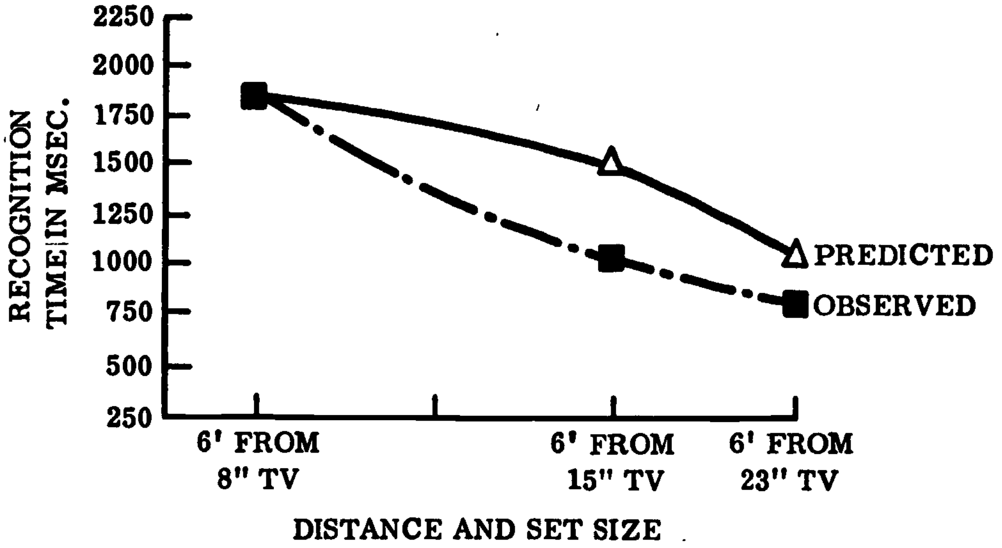

Figure 8

Predicted Recognition Time Compared to Observed Recognition Time With a Change in Screen Size

Calculating recognition time change related to viewer distance. Since Group 2 figures did not reach a level of statistical significance and the curve plotted for Group 2 sloped differently than curves plotted for Groups 1, 3 and 4, Group 3 figures were selected to evaluate change in distance using the recognition time formula. Here is the formula:

> Perception time for a given message when viewer distance is decreased = (given perception time in msec.) - (given perception time in msec. x 3.90 percent x decreased subject to screen distance in feet). Recognition time was calculated for a 6-foot distance from a 15-inch screen given recognition time for 11.25 feet from a 15-inch screen.
>
> (1693 msec.) - (1693 x 0.039 x 5.25) = 1346 msec.

Actual plotted value is 958 msec. The difference between plotted value and estimated value is, then, 388 msec., which is within the 453 msec. actual maximum error observed. This relationship is shown in Figure 9.

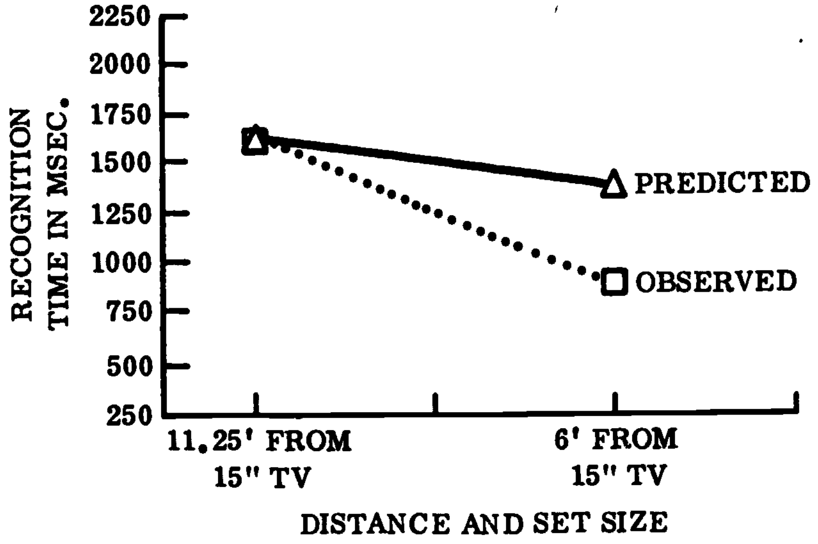

Figure 9

Predicted Recognition Time Compared to Observed Recognition Time With a Change in Viewer Distance

Analysis of Subjects

The questionnaire portion of the experiment revealed that the subject ages ranged from 25 to 64 years. The average age was 40 years. The modal age was 34 years with 5 subjects in this classification and the median age was 40 years.

The mode for education was the bachelor level. Approximately 5 out of 10 fell into this category. Master's degrees were held by about 4 out of 10. There was one subject whose formal education stopped at the high school level and five subjects held doctorates.

Of the 43 subjects 22 wore glasses while 21 did not, a nearly even split.

The height of the group ranged from 5-foot 4-inches to 6-foot 7-inches. The mode was in the 5-foot 8- inch plus to 5-foot 10-inch bracket which represented about 4 out of 10 of the subjects. Nearly 3 out of 10 were 5-foot 10-inches plus to 6-foot and approximately 2 out of 10 were 6-foot plus to 6-foot 2-inches. The sample then droped off sharply in both directions.

Subjects reported their states of energy, happiness and excitement rather uniformly in the mid range with medians along a 7 point scale of 3.5, 3.542, and 3.727 respectively.

To the question "Did you develop a method for recognizing the sentences?", a few more than 8 out of 10 responded yes. Of those who reported the method they developed, all but 1 looked at the stimulus sentence in descrete parts rather than trying to see the whole phrase at once.

About 7 out of 10 of the subjects felt that they improved their recognition time with experience at the tests.

More than 7 out of 10 reported that distance from the set affected their recognition time.

Nearly 8 out of 10 indicated that set size affected their recognition time while the rest reported it did not.

Subjects normally viewed television on sets ranging in screen size from 12-inch to 25-inch. The mode is the 19-inch screen, with 21-inch screens being the next most frequently viewed. Eight out of 10 watch television on sets ranging from 14-inch screens to 21-inch screens. Approximately 5 out of 10 normally sit directly in front of the screen. About 4 out of 10 normally sit off to one side. The rest either do not have a regular viewing position or did not respond to the question.

The distances from the set for normal viewing were reported as from 4 feet to 25 feet. Most common viewing distances fall between 8 and 15 feet. Approximately 8 out of 10 of the respondents watch from within this range.

About 4 out of 10 indicated that the chair from which they watch television is known as their chair. The question was posed as a possible further indicator of habitual fixed position viewing.

Color and black and white viewing habits reported are confusing. Normal viewing is reported as an even split between normally watch in color and normally watch in black and white. In a second question inquiring into percentages of color and black and white viewing, 19 reported watching more c than black and white, only 8 reported seeing more black and white than colo . 16 subjects did not respond to the question. This poor level of response could be a result of the wording of the two questions. Respondents may have felt they were being asked for the same information twice.

Relating Analysis of Scores to Analysis of Subjects

The subject analysis shows that almost 8 out of 10 of these subjects normally watch television on sets ranging in size from 14-inch to 21-inch.

Eight out of 10 subjects also report normal distance from set as ranging from 8 feet to 15 feet.

Using the distance and set size formulas previously developed, an estimate of recognition time variation was made for this group of subjects viewing 4 word sentences of the type described in this experiment.

Screen size. The maximum mean score for subjects under the most difficult experimental condition was 2003 msec. (6 feet from 8-inch screen). Most subjects interviewed in this experiment normally view television on screens ranging in size from 14 inches to 21 inches. The 14-inch screen was 6 inches larger than the given experimental screen size and the 21-inch screen 13 inches larger.

2003 msec. - (2003 x 0.029 x 6) = estimated recognition time value for 14-inch screen, 1662 msec.

2003 msec. - (2003 x 0.029 x 13) = estimated value for 21-inch screen, 1248 msec.

Adding the actual observed maximum error of 453 msec. to the high end of the range, 1662 msec., provided the longest probable recognition time under the stated conditions, 2115 msec.

Subtracting the actual observed maximum error of 453 msec. from the low end of the range, 1248 msec. provided the smallest probable recognition time under the stated conditions, 795 msec. The range represented here equaled 2115 msec. to 795 msec., or, 1320 msec.

This 1320 msec. range indicates that it is possible that the set size in this most frequently viewed range, from 14-inch to 21-inch screens, can result in well over a one second difference in perception time required to read a sample sentence of the type used in this experiment.

This difference would, of course, increase with even smaller screens than those considered here (14-inch to 21-inch), and more than 1 out of 10 subjects reported normally watching television on screens of 8 inches or less.

Viewer distance. The most frequently watched television screen size reported in this experiment was the 19-inch screen.

Using the screen size formula and the maximum mean score for subjects under the most difficult experimental condition (8-inch screen at 6 feet), recognition time was estimated for these subjects viewing a 19-inch set from 6 feet displaying the type of sentences used in this experiment. The 19-inch screen is 11 inches larger than the given experimental screen size.

2003 msec. - (2003 x 0.029 x 11) = 1364 msec. for recognition from 6 feet.

Applying the distance formula, recognition times were estimated for the range of distances from which most subjects in this experiment normally view their television sets, 8 feet to 15 feet. The formula used for this calculation was:

Given score minus (Given Score x 0.039 x decrease in viewer distance in feet)

This formula was used when the given score was that which represents viewing under the furthest condition of distance. In order to estimate upwards from the most optimum condition of distance, the formula had to be rewritten as:

Given Score plus (Given Score x 0.039 x increase in viewer distance in feet).

The calculated score for a 19-inch screen viewed from 6 feet was then inserted into the formula.

1364 + (1364 x 0.039 x 2) = estimated recognition time value for 8-foot distance = 1470 msec.

1364 + (1364 x 0.039 x 9) = estimated recognition time value for 15-foot distance = 1843 msec.

Subtracting the actual observed maximum error of 453 msec. from the low end of the range, 1470 msec., provided the smallest probable recognition time under the stated conditions, 1017 msec.

Adding the actual observed maximum error of 453 msec. to the high end of the range, 1843 msec., provided the largest probable recognition time under the stated conditions, 2296 msec. The range represented here equalled 1017 msec. to 2296 msec., or, 1279 msec.

It is possible that the viewer's distance from the television set in this most frequently used range of 8 feet to 15 feet can result in more than a one second difference in perception time required to read a simple sentence of the type used in this experiment.

Smaller screens would increase this difference over the same range of viewing distances, and larger screens would tend to lessen the effect.

CONCLUSIONS AND RECOMMENDATIONS

The statistical validity of the data collected during this experiment made it possible to draw a number of conclusions regarding the perception of short sentences on a television screen, under varying conditions of screen size and viewer distance.

Fully Supported by Data

The hypotheses stated in Chapter 1 were fully supported by the findings of the experiment.

Effect of screen size and viewer distance on recognition time. Experimental data, at a statistical probability level of 0.01, supported the hypothesis that television screen size on which a written message was displayed affected recognition time of that message when the message remained proportionally the same size to the overall size of the screen, and subject distance from the screen was held constant.

Experimental data at a statistical probability level of 0.01 supported the hypothesis that distance from the television screen affected length of time required to recognize a written message when the message's physical size was held constant and distance from the screen was varied.

Screen size, viewer distance and visual angle. Experimental data showed no significant difference in recognition time (p greater than 0.05) when subject to screen distance was changed but screen size was changed concurrently so that the stimuli would subtend the same visual angle.

This supports the hypothesis that viewer distance and television screen size, co-adjusted to subtend the same visual angle or maintain the same apparent size of the stimulus, will induce the same recognition time. This indicates that television screen size and viewer distance from the screen are reciprocal factors in recognition time for sentences presented on a television screen.

Calculating exposure time needed for recognition. Using formulas developed from Group 1 data, it was demonstrated that a rough estimate of recognition time could be predicted for the sentences presented to subjects in other groups of this experiment. Using measurement techniques of this experiment, data showed that within an actual observed maximum error of 453 msec. such predictions could be made.

Partially Supported by Data

Based on the results of this experiment it might be possible that the most frequently viewed range of television screen sizes provide for more than a 1-second difference in recognition time for simple sentences viewed by average subjects at a fixed distance. It is also possible that the viewer distance from the television set in the most frequent range of viewer distances might result in more than a 1-second difference in perception time required to read a simple sentence such as those used in this experiment.

The conclusion to be drawn from these possibilities is that the lack of established criteria for sizing words and letters in graphics production for television broadcasting, and the complete exclusion of receiver set size and viewer distance considerations from graphics designing, could be affecting the cost effectiveness of advertisers' messages. In teaching or training situations poor visual designs could be giving advantages to some students based purely on those students' distance from the screen.

Other Possible Implications

Although the bounds of this experiment limit any conclusions of the effect of a Distance and Size Perception-Time Effect in situations other than those specifically examined here, it is worth considering some other possibilities.

It is quite probable that changing the lettering size with proportion to the screen size would also have an effect on recognition time similar to the effect of changing screen size. This dimension should be explored and expressed in the rule-of-thumb formula.

Recognition time of geometric figures might be affected in the same manner as the recognition of sentences is in this experiment. Ability to comprehend a complex picture within a given exposure time might also be a function of screen size and distance.

CONCLUSIONS AND RECOMMENDATIONS

The assumption, for the sake of this experiment, that the change in recognition time for increasing screen sizes or for increasing distance from the set is a linear function of time needs verification. An experiment should be conducted to plot recognition time scores all along this hypothesized linear function. A far more thorough examination is needed for effects of both distance and screen size on recognition time.

To use the findings of this experiment in practical applications, this work should be carried several steps further. Using the visual angle of the stimulus as a basis, it might be possible to construct a series of tables for graphics producers to establish probabilities of viewer readability.

First, a standard range of recognition times for subjects of varied backgrounds, such as low income, slow processors, high income, high achievers, and so forth, should be experimentally established for a standard range of message types. These recognition times should be established as standard numbers for a given condition and tables should be constructed as reference tables for the graphics producer.

The graphics producer would come to the reference table with the knowledge of normal distances and set sizes used by his target audience and also extremes within his area of interest. His decision would be on the percentage of his audience that he would want to be certain would be able to read his message. He would trade off percentage of sure readership against cost to keep the message on the screen longer. Using the proposed standard range of recognition times table, he could determine the length of air time needed for the lettering size he wishes to use. Or, he could determine the lettering size required for the air time to which he is restricted.

The second requirement for such a system would necessitate a field study. Market groups would have to be surveyed, and normal viewing distance and standard set sizes would have to be established for target audiences of interest. This knowledge would have to be available to the graphics producer before he could use the proposed standard range of recognition times table.

Manufacturers of television sets might be provided with set size and viewer distance information and encouraged to provide industry established recommended viewing distances in the literature accompanying their products. This would help tie the graphics producers and audiences together for improved communication.

Some additional analysis of the data collected for this experiment might be of interest in trying to establish relationships between such things as age, education or other subject perculiar characteristics and recognition time of short sentences presented on a television screen.

The question of sound with picture could be investigated to see how recognition time is affected by complementary, supplementary, and contrasting sound tracks as distance and set size are varied. This study was conducted only in black and white. A similar study might be performed in color to see what differences color exerts on the observed effect. It would also be useful to compare static presentation with the crawl technique. It would be useful to see if geometric patterns or other purely visual, as opposed to verbal, material under similar experimentation exhibited the same kind of recognition time curves as those observed here.

Theoretical data would suggest that very little difference probably occurs in recognition time because of the flash exposure technique at the length of durations being used in this experiment. However, it would be of some theoretical interest to perform this same experiment using a different technique for measuring exposure. Instead of using flash exposures, measure subject reaction time to sentences of long continued exposure. A comparison of values obtained in this study and those obtained in a study such as that suggested would determine how much effect repeated exposures would have on recognition time at these exposure durations.[39]

The data collected for this experiment are available for further analysis in Temple University Library's Conwellana Templana Collection, Special Collections Archives.

Available there are raw data sheets, IBM cards used in the analysis of data, the original 16 mm. motion picture stimulus film and the final 1-inch video stimulus tape.

Additional data were collected during the questionnaire portion of testing for a separate study attempting to relate recognition time with cognitive

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[39] R. N. Haber and M. Hershenson, "The Effects of Repeated Brief Exposures on Growth of a Percept," Journal of Experimental Psychology, 69:40-46, January, 1965.

structure. A verbal sentence completion cognitive structure test, as described in Schroder's Human Information Processing,[40] was used to collect those data which remain attached to the raw data sheets on file with the materials used in this study.

SUMMARY

In the production of television graphics involving written messages, it is quite possible that graphics designed under the present general rules-of-thumb may be imperceptible to a large portion of the producer's target audience in some cases, and wasteful of air time by being kept on too long in other cases.

When communicating a great deal of information in a short period of time is critical, this factor becomes important. There are no scientifically developed guidelines to establish the limitations which must be met to assure audience readability.

The presently accepted standards, such as lettering 1/60th picture height being readable,[41] are inadequate to establish reliable limits of viewer readability in applications in which air time is a critical factor. Existing standards of graphics design do not take into consideration the Distance and Size Perception-Time Effect, identified in the present study, taking place at the receiver's end of the communication loop.

[40] Harold M. Schroeder, Michael J. Driver, and Siegfried Streufert, Human Information Processing, (New York: Holt, Rinehart and Winston, Inc., 1967), p.p. 185-204.

[41] Gerald Millerson, The Technique of Television Production, (Harford Works: Fletcher and Son, Ltd., 1966), p. 354.

The present study demonstrated that a Distance and Size Perception-Time Effect exists. Forty-three subjects were randomly selected from General Electric's Space Division engineering personnel. Four different test conditions were designed to observe recognition time of short sentences on television as screen size and subject distance from the screen were varied.

Data showed, at a statistical probability level of 0.01, that recognition time of a short sentence presented on a television screen was affected by the size of the television screen and the viewers' distance from it. The observed effect was expressed in two formulas, one for screen size changes and one for changes in subject distance from the set.

Perception time for a given message when screen size is increased = (given perception time in msec.) - (given perception time in msec. x 2.90 percent x inches of increase in screen width).

Perception time for a given message when viewer distance is decreased = (given perception time in msec.) - (given perception time in msec. x 3.90 percent x decreased subject to screen distance in feet).

With today's emphasis on accelerating the speed of communicating information, the Distance and Size Perception-Time Effect should be further studied for integration into the planning and design of visual communications materials.

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APPENDIX A

TELEPHONE INTERVIEWS WITH LOCAL TELEVISION GRAPHICS DESIGNERS

The art departments of three Philadelphia television stations were questioned by telephone concerning the criteria used to determine letter size for television graphics. The following statements summarize the information provided during those telephone conversations held September 22, 1971.

WCAU-TV - Creative Arts Director, Mr. Chavenson, reported that letter size and number of letters per line are judgement factors based on the demands of each job. Frequently, the sponsor demands copy regardless of aesthetics or readability.

WPVI-TV - Art Director, Noel Miles, uses the general standards described in Zettl's Handbook and limits copy to ten words maximum on one slide.

KYW-TV - Art Department Head, Ron Hower, establishes the minimum size for a letter to be such that it will fill 4 or more horizontal scan lines on the television receiver. Fine serf and fancy type faces are not advisable. Nothing under 1/4" should be used on an 11x14 card. He also reports that disclosures are frequently done under this size because they must be there, but the producer does not care if they are read.

APPENDIX B

WORD LIST FOR SENTENCE PREPARATION

Sentences were constructed for this experiment by using words with pre-determined frequencies of usage.

The following list of words was extracted from E. L. Thorndike and I. Lorge, The Teacher's Word Book of 30,000 Words (New York: Columbia University, 1944).

These words are words of three to six letters with occurrences of 100 or over per million.

able	air	army	bear
about	all	arrive	beat
above	allow	at	became
accept	almost	arthur	become
across	alone	ask	been
act	along	away	before
action	also	baby	began
add	among	bad	begin
admit	amount	back	behind
affair	and	bag	being
afraid	animal	ball	belong
after	answer	bank	below
again	any	base	beside
age	appear	battle	best
ago	are	bay	better
agree	arm	be	beyond

big
bill
bind
bit
black
blood
blow
blue
board
boat
body
book
born
both
box
boy
branch
break
bridge
bright
bring
broken
brown
build

built
burn
busy
but
butter
buy
by
call
came
camp
can
cannot
car
care
carry
case
catch
caught
cause
cent
center
chair
chance
change

charge
cheek
chief
child
church
circle
city
claim
class
clean
clear
close
cloud
club
coal
coat
cold
color
come
common
cook
cool
corner
cost

cotton
could
count
course
court
cover
cross
crowd
cry
cup
cut
daily
dance
danger
dare
dark
date
day
deal
dear
death
decide
deep
degree

demand
desire
did
die
dinner
direct
divide
doctor
does
dollar
door
double
doubt
down
draw
dream
dress
drink
drive
drop
dry
due
during
duty

each
early
earth
east
easy
eat
edge
effort
egg
eight
either
else
end
enemy
enjoy
enough
enter
escape
Europe
even
ever
every
except
expert

eye
face
fact
fail
fair
fall
famous
far
farm
farmer
fast
fat
father
favor
fear
feet
fell
fellow
felt
few
field
fifty
fight
figure

fill
fine
finger
finish
fire
first
fish
fit
five
floor
flow
flower
fly
follow
foot
for
force
forest
forget
form
former
forth
found
four

France	god	has	hope
free	going	hat	horse
French	gold	have	hot
fresh	golden	head	hour
friend	gone	health	house
from	got	hear	how
front	grant	heard	human
fruit	grass	heart	hurry
full	gray	heat	hurt
future	green	heaven	idea
gain	grew	heavy	ill
game	ground	height	inch
garden	grow	held	indeed
gate	guard	help	indian
gather	guess	Henry	into
gave	guide	her	iron
gentle	had	here	island
George	hair	high	issue
German	half	hill	itself
get	hand	his	job
girl	hang	hold	join
give	happen	hole	John
given	happy	home	joy
glass	hard	honor	judge

just	learn	loss	milk
keep	least	lot	mind
kept	leave	love	mine
kill	led	low	minute
kind	left	lower	miss
king	leg	made	modern
kiss	length	make	moment
knee	less	man	money
knight	let	manner	month
know	letter	many	moon
known	lie	march	mother
labor	light	mark	mount
lady	left	master	move
laid	life	matter	much
lake	line	may	music
land	lip	mean	must
large	listen	meat	name
last	little	meet	narrow
late	live	member	nation
laugh	London	met	native
law	long	method	nature
lay	look	middle	near
lead	lord	might	nearly
leader	lose	mile	neck

need	one	people	queen
never	only	period	quite
new	open	person	race
news	order	pick	rain
nice	other	piece	ran
night	ought	place	rate
nine	our	plain	rather
none	out	plan	reach
north	over	plant	read
nose	own	play	ready
note	page	point	real
notice	paid	poor	really
now	pain	post	reason
number	paint	pound	record
object	pair	power	red
obtain	paper	press	refuse
ocean	Paris	pretty	regard
off	part	price	remain
offer	party	prince	remove
office	pass	proper	reply
often	past	prove	report
oil	path	public	require
old	lay	pull	rest
once	peace	put	result

return
rich
ride
right
ring
rise
river
rock
roll
roof
room
rose
round
rule
run
rush
safe
said
sail
salt
same
sat
save
saw

scene
school
sea
season
seat
second
see
seek
seem
seen
sell
send
sense
sent
serve
set
settle
shade
shall
shape
share
she
ship
shoe

shop
shore
short
shot
should
shout
show
sick
side
sight
sign
silver
simple
since
sing
single
sir
sister
sit
six
size
skin
sky
sleep

small
smile
smoke
snow
soft
sail
sold
some
son
song
soon
sort
soul
sound
south
space
speak
speech
spend
spirit
spoke
spot
spread
square

stand	supply	this	try
star	sure	those	twelve
start	sweet	three	two
state	system	tie	type
stay	table	till	uncle
step	take	tire	under
stick	taken	to	union
stock	talk	today	until
stone	taste	told	upon
stood	teach	too	use
stop	tell	took	valley
story	ten	top	value
stream	than	touch	very
street	that	toward	view
strike	the	town	visit
strong	their	trade	voice
study	then	train	vote
such	there	travel	wait
sudden	these	tree	wall
suffer	they	tried	want
sugar	thin	trip	war
suit	thing	true	warm
summer	think	trust	was
sun	thirty	truth	wash

watch	which	window	write
water	while	wing	wrong
wave	white	winter	wrote
way	who	wise	yard
wear	whole	wish	year
week	whom	with	yellow
weight	why	within	yes
well	wide	woman	yet
went	wife	wonder	you
were	wild	word	young
west	will	world	your
what	wind	worth	youth
when	win	would	

Sentences were then constructed from this word list. Criteria for sentences were: sentences had to make sense, but must not be sensational nor be phrases that are in common usage. The structure of each sentence was established to be a four letter word, followed by a three letter word, followed by a five letter word, followed by a six letter word. Thirty sentences were constructed:

1. gold can force people
2. none had doubt enough
3. some few enjoy school
4. make the youth settle
5. keep the earth farmer
6. each age found wonder
7. kill the enemy beyond
8. camp let smoke escape

9. hear our music leader
10. have his horse follow
11. race ran close finish
12. love and honor father
13. such joy shall return
14. only ten could remain
15. pick six which travel
16. long ago peace spread
17. find one sweet flower
18. fear for first degree
19. each ask every desire
20. make the water divide
21. save the green forest
22. look for plain reason
23. hold off every danger
24. wild but quite gentle
25. seek out power within
26. that can never happen
27. find the small island
28. none can laugh enough
29. send the water supply
30. fish one whole summer

APPENDIX C

CENSUS OF TELEVISION ADVERTISING USING WRITTEN WORDS

In deciding whether light letters on a dark background or dark letters on a light background should be used in experimental tests, periods of television advertising were observed. Out of 34 ads observed, 25 used white letters on a dark background, while only 9 used dark letters on a light background. The written matter observed for purposes of this experiment were sentences giving commercial messages. Letters which appeared as part of a product brand symbol or label were not considered in this survey.

Monday October 25, Philadelphia, Pennsylvania.

Channel 3	Commercial	Letters on background
8:30 PM	Miller Beer	light on dark (wave background)
8:45 PM	Volkswagen	light on dark
8:55 PM	Close Up	dark on light
9:00 PM	Life Buoy	dark on light
	Esso	light on dark
	Dristan	dark on light
	Baby Magic Lotion	dark on light
	Chocolate Oatmeal	dark on light
9:50 PM	Kellogg's	light on dark
	Kraft	light on dark
	Cadillac Dog Food	light on dark
10:15 PM	Admiral	light on dark
	Neosinephrine	light on dark

Saturday October 30, Philadelphia, Pennsylvania.

Channel 10	Commercial	Letters on background
8:30 PM	Clairol	light on dark
	4-Way Nasal Spray	dark on light
	Whirlpool	dark on light
8:45 PM	Big John Beans	light on dark
	Excedrin	light on dark
9:00 PM	Hawiian Punch	light on dark
	Kellogg's	both
9:15 PM	Kellogg's (same message, different ad.)	light on dark
9:30 PM	Bufferin	light on dark
	Playtex	light on dark
	Progresso	light on dark
	Wisk	dark on light
10:00 PM	Sine-Off	light on dark
	Twice as Nice	dark on light
	WDBR Sweepstakes	light on dark
	Dryfus Fund	dark on light
10:25 PM	American Motors	light on dark
10:45 PM	Dristan (Vapor Spray)	dark on light
	Stroehman's Bread	dark on light
11:00 PM	Bayer Asperin	light on dark
	Prestone	light on dark

Sunday October 31, Philadelphia, Pennsylvania.

Channel 3	Commercial	Letters on background
9:00 PM	Cheer	light on dark
	Jif	light on dark
	Gimbels	light on dark
	Chevrolet	light on dark
	Kraft	dark on light
9:30 PM	Cadillac Dog Food	light on dark
9:45 PM	Chevrolet	light on dark
10:00 PM	Ex Lax	light on dark
	Dristan	light on dark
	Chevrolet	light on dark
	7 Up	dark on light
	Sunbeam Iron	light on dark
	Protein 21 Hair Spray	light on dark

APPENDIX D

SAMPLE PAGES OF GENERAL ELECTRIC PERSONNEL LIST

SPACE SYSTEMS
ORGANIZATION CODE NUMBERS
SUMMARY

General Manager -	Space Systems	L. L. Farnham
	Valley Forge Operations	L. L. Farnham (A)
1G00, 1H00, 1J00, 1M00, 1R00, 1T00, 1200, 1300, 1600, 1700, 1900	Technical Operations	W. W. Levy
1400	Earth Observatory Programs	I. S. Haas
1K00	S-193 Program	R. J Katucki
1A00, 1E00, 1F00, 1W00	Nuclear Systems Programs	D. F. Huebner

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DEPARTMENT MANPOWER BY OPERATION REPORT NO. 6,150 W/E 10/10/71

CP-CLASS	P	SEN-DATE	PAY NO	NAME	SEX	JOB TITLE	JOB CODE	LOC	ROOM	EXT
1421-101	3	07/13/65	01295	W J ANDIARIO	M	SYS TEST PLAN EVAL ENG	91224474	VF	U4426	4216
1421-104	3	12/14/61	02236	K G BAHMILLER JR	M	SYS TEST SPECIALIST	94224353	VF	U4426	4746
1421-104	3	08/01/66	03726	S J BARTNICKI	M	SYSTEM TEST SPECIALIST	94224353	VF	U4426	4746
1421-104	3	11/28/61	06097	C B BILLMAN	M	SUPV SYS TEST SUPPORT	44224572	VF	U4438	4212
1421-101	3	09/01/67	06309	R L BIRMAN	M	SYS TEST ENGR	91224424	VF	U4438	4347
1421-104	3	10/09/61	06846	H L BLUM	M	SYSTEM TEST SPEC	94224353	VF	U4438	4212
1421-101	3	06/11/55	08240	H BOYS	M	MGR OBSERV SYS TEST	10000000	VF	U4426	2867
1421-101	3	10/07/58	10238	J D BROWNE	M	SYS EVAL ENG	91211329	VF	U4438	4272
1421-101	3	05/01/67	11354	R C BURNS	M	MGR NIMBUS TEST OPER	41260493	VF	U2443	2693
1421-104	3	10/11/61	13196	J A CARSON	M	SYSTEMS TEST SPECIALIST	94224552	VF	U4426	3784
1421-104	3	08/01/57	22325	J A DELLA PENNA	M	SYS TEST COMP SPECIALIST	94224565	VF	U4426	7227
1421-104	3	05/28/62	24418	H L DOLINGER	M	SYS TEST SPECIALIST	94224552	VF	U4438	2505
1421-101	3	09/21/67	26614	R C EDGAR	M	SYS EVALUATION ENG	91211307	VF	U4438	2945
1421-101	3	09/15/65	28878	J K FERGUSON	M	SYS EVAL ENGR	91211329	VF	U4426	4683
1421-101	3	06/24/68	28980	J F FERRI	M	S/E FAC + TST EQUIP	91260497	VF	U2443	2152
1421-104	3	10/08/62	29865	P H FITZGERALD	M	DATA SYS ANAL	94224536	VF	U4438	6427
1421-104	3	05/07/62	33178	R G GAUKER	M	DATA SYSTEM ANALYST	94224464	VF	U4426	2356
1421-101	3	07/18/61	33181	N F GAUSS	M	MGR NIMBUS B2 CON SYS	41260544	VF	U4426	4144
1421-104	3	08/23/56	34227	A J GILBERT JR.	M	SYS TEST COMP SPEC	94224341	VF	M6449	4239
1421-104	3	01/24/49	35834	D B GORDON	M	SYSTEMS TEST SPECIALIST	94224552	VF	U4426	2043
1421-101	3	09/05/67	37800	P GIUSTINO	M	SYS EVAL ENG	91211329	VF	U4438	6213
1421-104	3	08/05/68	37921	H H GUNTHER	M	SPEC NIMBUS TEST OPER	94260516	VF	U2443	2152
1421-104	3	07/02/51	37967	W A GUSTAFSON	M	SYS TEST SPEC	94224422	VF	U4438	1380
1421-101	3	07/05/61	40123	C C HARZ JR	M	SYS TEST ENGINEER	91224424	VF	U4426	6429
1421-101	3	08/24/61	41830	R J HICKS	M	MGR SYS TEST+EVAL	31260357	VF	U4438	3104

[illegible] MANPOWER BY OPERATION REPORT NO. 6.150 W/E 10/10/71

OP-CLASS		[illegible] DATE	PAY NO	NAME	SEX	JOB TITLE	JOB CODE	LOC	ROOM	EXT	E
1421-[illegible]	[illegible]	[illegible]/23/43	42435	J J HODA	M	MGR TEST PROG INTEG	31260355	VF	U4438	4042	4
1421-104	3	10/04/56	42617	J J HOFFACKER	M	SYSTEMS TEST SPEC	94224354	VF	U4426	4986	4
1421-104	3	03/04/57	47372	D R KEER	M	SUPV IMPLEM + CHECK	10000000	VF	M8458	7227	7
1421-101	3	[illegible]/22/56	47896	S J KEER	M	SYS TEST ENG	91224553	VF	U4426	3626	3
1421-101	3	02/24/6[illegible]	49095	R L KING	M	SYSTEMS TEST ENGR	91224424	VF	U4426	3784	3
1421-101	3	09/29/67	52232	R K LANG	M	SYS EVAL ENGR	91211307	VF	U4438	2945	2
1421-101	3	08/26/51	55278	C J LOEPER	M	SYSTEMS TST ENG	91224553	VF	U4426	4236	4
1421-104	3	11/20/61	56095	T R LUDWIG	M	SYS TEST SPECIALIST	94224468	VF	U4425	4216	4
1421-101	3	03/03/52	56365	L L LUX	M	SYSTEMS TEST ENGINEER	91224369	VF	U4426	3784	3
1421-101	7	06/16/69	59960	R J MCCUNNEY	M	STEP PROGRAM	99999905	VF	U4426	1366	2
1421-101	3	06/10/68	64182	R A MILLER	M	SUPV OBSERV TEST OPER	10000000	VF	M8502	1110	1
1421-101	3	11/06/61	64185	R C MILLER	M	MGR SYS TST+EVAL	31260357	VF	U4426	2666	3
1421-101	3	06/01/60	65702	F H MORGAN JR	M	S/E SYSTEMS EVAL	61260523	VF	U4438	3829	0
1421-104	3	04/06/59	67438	J J MURRAY	M	SYS TEST SPEC	94224353	VF	U4438	2505	6
1421-104	3	06/10/68	68905	H L NORRIS	M	SPEC/NIMBUS TEST OPER	94260516	VF	U2443	2152	7
1421-101	3	01/02/62	72142	P PEREZ	M	SYS TEST ENG	91224553	VF	U4426	3236	
1421-101	3	08/05/63	80932	P B SAMPSON	M	SYS TEST DATA ENGR	91224431	VF	U4438	4272	3
1421-101	3	11/19/59	83540	A R SHAKARJIAN	M	SYS TEST ENGR	91224424	VF	U4426	3257	
1421-101	3	10/31/66	85306	A J SMITH	M	SYS EVAL ENGR	91211330	VF	U4426	2965	6
1421-101	3	01/14/57	86866	C SPADARO	M	SYS TEST ENG	91224423	VF	U4426	6429	6
1421-104	3	12/14/52	87598	M C STATHOPOULOS	M	SYS TEST SPECIALIST	94224353	VF	U4426	4986	4
1421-104	3	01/08/62	89285	G D STUM	M	SYS TEST SPEC	94224552	VF	U4426	4216	4
1421-104	3	12/26/61	89659	F H SURGENER	M	SYS TEST SPEC	94224321	VF	U4426	4746	3
1421-104	3	04/05/56	90251	B D SYKES	M	SUPV SYS TEST SUPT	44224572	VF	U4438	4347	4
1421-104	3	04/29/57	90291	E SZARY	M	SYS TEST SPEC	94224552	VF	4426	3784	3

APPENDIX E

TELEPHONE INTERVIEW OF PROSPECTIVE SUBJECTS

The following questions were posed over the telephone to each of the proposed subjects.

"My name is Earl Lewin. I work here at Valley Forge and am also working on my master of science degree in communication at Temple University. During the week of December 27th, I will be conducting an experiment at the Valley Forge Facility. It will require viewing a five-minute video tape and take about 10 minutes total of your time. Would you be willing to participate?"

In order to analyze my sample which was randomly selected from the Space Division personnel list, I'll need you to answer a few questions for me:

1. your age at last birthday
2. your most advanced academic degree
3. do you wear glasses when watching TV?
4. your height

Thank you. I will notify you as to the exact time and location."

If asked for further information about the experiment the following answer was given:

"I don't want to tell you any more about the experiment because I am afraid I might sensitize you in some way that might bias my data."

APPENDIX F

SAMPLE QUESTIONNAIRE

QUESTIONNAIRE

Part I

1. General state of being at start of test (indicate your location along this 7 point scale with an "X" over the appropriate dash).

   energetic _:_:_:_:_:_:_ tired

   happy _:_:_:_:_:_:_ sad

   excited _:_:_:_:_:_:_ bored

2. As you took this test, did you develop a method for perceiving the messages?

   yes ______
   no ______

3. If yes to No. 3, could you describe it very briefly in just a few words? If not, leave space blank.

   ____
   ____
   ____

4. Do you think your speed in recognition of these sentences changed as you became more accustomed to the test?

   yes ______
   no ______

5. Do you think your distance from the set affected your speed of recognition of the sentences?

   yes ______
   no ______

6. Do you think the size of the TV set affected your speed of recognition of these sentences?

   yes ______
   no ______

7. What size set do you normally watch TV on? ______________________________

8. Do you normally sit directly in front of the set when you are viewing TV, or off to one side?

   in front ______________
   to the side ______________

9. How far from the TV set do you normally sit? If more than one TV in house, give size of set and distance if distance differs for different size TV sets.)

   ____
   ____
   ____

10. Is the chair you normally use known in the household as "your chair" to watch TV from?

    yes ______
    no ______

11. Do you normally watch TV in:

    color ______________
    black and white ______________

12. If you have both color and black & white sets, how would you estimate your viewing of each?

    color ______% of the time
    b & w ______% of the time

Part II

On the following pages, you will find a word or an incomplete sentence. Write a three or four sentence paragraph which starts with the word (s) given. Write whatever you feel like writing -- there are no right or wrong answers. Please complete all six paragraphs.

1. When I am criticized....

2. Rules....

3. When I am in doubt. . . .

4. Confusion. . . .

5. Television....

6. **Politics....**

APPENDIX G

VERBAL INSTRUCTIONS TO TEST SUBJECTS

VERBAL INSTRUCTIONS TO TEST SUBJECTS

"I am going to play a videotape on the TV screen directly in front of you. The tape has an ocean background and you will intermittently see short written messages appear over the scene. Please repeat the message aloud when you believe you can read it correctly.

Each message will appear a number of times before a new message is presented. If you think that you have misread a message then repeat it correctly when you perceive it correctly. Otherwise, remain silent until you recognize a new message.

This is not a test of ability so just relax and enjoy it."

--after the ninth sentence--

"Now I am going to reposition your chair and after I do that, the tape will continue. Would you stand for a minute please?" (chair is moved) "All right, now, if you will be seated again."

--after the 18th sentence--

"One more repositioning of your chair and then we will conclude this tape. Would you stand once more please" (chair is moved) "Please be seated again."

"That is the end of the tape. Now, if you would, please sit down over here and fill out this questionnaire. This should only take about 5 minutes.

Thank you for participating in the experiment."

APPENDIX H

SCORE SHEET

Name ____________ Age ______ Degree _________ Eyesight _________ Height _______

Time of Test _________ Date _________

Group ______

	Treatment A	Treatment B	Treatment C
Set Size	_______	_______	_______
Subject Distance	_______	_______	_______

Sentence	Exposure Time in Motion Picture Frames 1	2	3	4	5	6	7	8	9	10	11	12	Body Position At Response Time	Calculated Exposure at Time of Recognition
Such joy shall return													N F	
Each age found wonder													N F	
Some few enjoy school													N F	
Each ask every desire													N F	
Save the green forest													N F	
Wild but quite gentle													N F	
Hold off every danger													N F	
Send the water supply													N F	
That can never happen													N F	
Make the youth settle													N F	
Fear for first degree													N F	
Have his horse follow													N F	
Love and honor father													N F	
Keep the earth farmer													N F	
Kill the enemy beyond													N F	
Find the small island													N F	
Gold can force people													N F	
Make the water divide													N F	
None had doubt enough													N F	
Look for plain reason													N F	
Hear our music leader													N F	
Race ran close finish													N F	
Pick six which travel													N F	
Find one sweet flower													N F	
Camp let smoke escape													N F	
Only ten could remain													N F	
Seek out power within													N F	